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TOW Gunner Selection

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Gunner selection was addressed in a two-stage ~~effort~~: (1) Advanced Infantry Training graduates entering TOW training at Fort Benning were examined prior to and during training. A number of personal, demographic, and behavioral measures were taken and discriminant analyses were run to try to differentiate trainees who succeeded at training (Qualified on the M-70 simulator) from those who did not. (2) Subsequently, a ~~TEA~~ test was conducted at the TRADOC Combined Arms Test Activity (TCATA) in which over 200 soldiers were trained, and then fired live missiles. Similar demographic data, (Continued)

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etc., were collected on this group and similar discriminant analyses were performed. The aim of these analyses was to predict/select those gunners who would actually hit a tank target in live fire. Four separate selection models were developed: two for training success, and two for live fire success.

Selection models were successfully developed for training on the M-70 simulator. However, the TCATA test showed that M-70 success was not significantly related to live fire success. Attempts to select gunners for the live fire situation were successful statistically, but the contribution of the selection model was found to be very small in terms of likelihood of successful gunnery. This is largely due to the fact that unselected and virtually untrained gunners were found to perform very well with the TOW system in the TCATA test. The test groups achieved hit probabilities, even with minimum training, which closely approximate the designed system potential.

TOW GUNNER SELECTION

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TOW GUNNER SELECTION

INTRODUCTION AND SUMMARY OF FINDINGS

In the past decade the Army has fielded a new class of anti-armor weapons for Infantry use. These new weapons differ from the earlier anti-armor systems in one major respect. While the earlier weapons were ballistic weapons which required aiming, lead, etc., to hit the target, the new weapons fire wire-guided missiles, which also require continuous tracking of the target throughout the missile's flight. Thus not only does the soldier have the usual tasks of target acquisition, sighting, and aiming, he must also maintain continuous sight alignment on the target to bring the missile to the target. This differs greatly from the "fire and forget" characteristics of the earlier weapons, e.g. - the Bazooka, and the 90 mm Recoilless Rifle. The heavy anti-tank weapon, TOW (Tube-launched, Optically-tracked, Wire-guided), and the medium range weapon, Dragon, are the two such weapons currently fielded.

Introduction of these systems into the Army inventory brought to light a potential training and/or personnel selection problem. It was believed that the sustained tracking task required considerable special training and might require abilities beyond the capacity of most Infantry soldiers. Accordingly, the Training and Doctrine Command (TRADOC) instructed the infantry School (USAIS) to conduct a series of training effectiveness analyses (TEAs) of these systems and their associated training programs. USAIS subsequently requested research support from the Army Research Institute - Fort Benning Field Unit, to assist in these TEAs. This research has been directed toward assistance in design and conduct of the TEA programs and more specifically toward the question of whether gunner selection techniques were either required or possible for these systems. A specific work unit was initiated in 1976 to examine the feasibility of development of selection models for both TOW and Dragon. This report summarizes the findings of the TOW-related research and presents models developed for prediction of gunner success in both simulator training and live firing. Dragon related research will be reported separately.

PROBLEM

TOW training suffers from a constraint not usually found in weapons systems. This is due to the extreme cost of the missile itself. This cost is such as to preclude live firing (even of inert rounds) in initial training. Only a limited number of missiles are available for demonstration firing in the initial training and for annual practice. This means that essentially all training must be accomplished without live firing. To meet this need, the M-70 tracking simulator system was adopted as the major training device for tracking and as the criterion for successful

trainees as well.[1] When the M-70 system was adopted for training, essentially nothing was known about the degree to which its use approximated live firing of the missile system. Similarly, the criterion scores for use with the M-70 to "qualify" gunners for TOW were developed arbitrarily and with no known relationship to live fire tracking or hit probabilities. The M-70 scores are measures of the percentage of time the gunner is on-target during a tracking period (representing the missile flight time). Arbitrary cut off scores determine whether the gunner qualifies as Expert, First Class, or Second Class. This application was based on the assumption that a gunner who could maintain the sight alignment on target continuously throughout the track was more likely to hit the target than one who could not. The concern with training effectiveness and of possible selection of gunners arose when it was noted that these arbitrary M-70 cutoff scores were causing a considerable portion of TOW trainees to be classed as Unqualified. In TOW Trainer classes during 1975-1976 at Forts Polk, Bragg and Benning, as high as 50% of some classes were found unqualified. While this percentage was an extreme case, it and similar numbers caused the TRADOC and USAIS concern with gunner training and selection techniques. Accordingly, ARI initiated research into the TOW training problems and the associated question of the feasibility of selection of TOW gunners to improve training results and, presumedly, subsequent live fire performance. ARI has investigated the development of selection models for the M-70 training task and for live fire performance of TOW gunners. ARI also investigated the relationship between M-70 performance and the live fire performance of gunners.

RESEARCH APPROACH

An initial step in the development of selection models was a detailed analysis of the TOW gunner's task requirements. This was essential to an understanding of the physical and psychomotor requirements on the gunner and was the basis for determination of the gunner characteristics which might impact on success or failure at the task. From these analyses and from literature searches, about forty five variables were identified as being potentially related to gunner performance. These variables include anthropometric measures (e.g. hand length), demographic measures (e.g. education), aptitude measures (ASVAB scores), self-report behavioral items (e.g. smoking), and other behavioral measures (e.g. pursuit rotor performance). (All variables are listed in Appendix A.)

Criterion measures used for the prediction/selection model for training success were M-70 criterion scores. Actual hit/miss results were the criterion for the live fire prediction model. Radial miss distance for

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[1] Descriptions of both the TOW system and the M-70 simulator system are presented in later sections of the report.

live fire performance was also considered for use in this prediction model, and was investigated in the analyses of the live fire data.

Both training and personal data for the prediction/selection model for the training (M-70 performance) were collected from 307 soldiers undergoing TOW training subsequent to AIT at Fort Benning during January through April 1977. The resultant prediction/selection models are necessarily based on success in the training program in effect at that time.

Data for the live fire selection model were collected by the TRADOC Combined Arms Test Activity (TCATA) during a test of TOW training effectiveness designed by USAIS, TCATA, and ARI and conducted at Fort Hood, TX, during March through May of 1978.[2] Personal characteristics data to be collected for all gunners were defined by ARI as were questionnaires to address the attitudes of gunners toward the system and the training programs. Measures of Effectiveness (MOE) collected included the hit/miss of the live round and the radial miss distance from the center of mass (RDCM). Different groups of gunner/trainees were trained under different programs during the TEA, however, the TCATA analysis showed that the training program used had no significantly different effects on the MOE. Therefore, for purposes of the selection model development, all groups were combined. This yielded a total of 222 soldiers with relatively complete data on all personal characteristics and on the MOE. For 54 of these trainees, much M-70 training performance data were also collected; and, for all 222 personnel, a restricted set of ten M-70 tracks was measured, either in the first training session, or, for those trained without the M-70, after live firing.

Development of the selection models for both M-70 performance and live fire performance followed the same techniques. Data were first intercorrelated to determine which variables would be most useful in development of the selection model and to eliminate predictor variables which were closely correlated with others and thus redundant. Where a pair of variables was correlated at $\pm.75$ or higher, the variable with least rational relation to the criterion was eliminated. Multiple correlations were then applied to the data to estimate the degree of predictability of the criterion and relative contribution to that prediction by each variable. Finally, discriminant analyses were applied to the data sets with the object being to discriminate between the persons who surpassed or failed to meet a defined criterion (those who hit and those who missed, in the live fire). Details of the analyses specific to each model development are presented in later sections of the report.

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[2]This test has been reported in detail by TCATA: Training Effectiveness Analysis (TEA) - TOW (Part I). HQ, TRADOC Combined Arms Test Activity, Ft Hood, TX. Sept 1978.

SUMMARY OF FINDINGS

Findings are summarized separately for the development of the selection models based on M-70 performance criterion and those based on the live fire performance.

Selection/Prediction for M-70 Training Success

In developing the selection models for successful M-70 training, the criterion used was based on the combined performance scores obtained in the 5 milliradian (Mr) task (Task A) and the 25 Mr task (Task C). This combined score was used, and Task B was ignored, because preliminary analyses showed Task B to be highly correlated with both Tasks A and C, while these were less highly correlated. Specific criteria were developed for each of eight possible "training success" levels defined in part by the then-current levels established on tasks A and C for Expert, First Class, and Second class gunners. The eight criterion levels were: 1650 points or better; 1500 or better (equivalent to Expert scores on the two tasks); 1430 or better; 1370 or better; 1300 or better (equivalent to First Class); 1230 or better; 1170 or better; and, 1100 or better (equivalent to Second Class). These multiple criteria were developed primarily to evaluate the effect of the different criterion levels on the effectiveness of the prediction/selection models. It was also felt that the evaluation might be useful in reassessment or redesignation of qualification criteria when these data could subsequently be related to live fire performance.

Discriminant analyses were performed against each of these eight criteria using data from 209 cases randomly selected from the 307 cases available from the Fort Benning Post-AIT TOW training group. The remaining 98 cases were used as a "hold-out" sample for validation of the success of the discriminant function and its use in classifying these persons. Two separate models were constructed. The first used initial M-70 training scores (the means of the first four training trials on each of Tasks A and C) as discriminating variables. The second model includes only variables available prior to the start of training. Each model was examined in relation to each of the eight criterion levels.

M-70 Included Model Results. The detailed results of the discriminant analyses with the initial M-70 scores included are presented in a later section. Table 1 summarizes the results of selection for the criterion levels corresponding to Expert, First Class and Second Class. The table shows the percentage of cases successfully classified (and those selected or rejected appropriately) for both the calculation and the validation cases. Table 2 lists the variables found to contribute significantly to discrimination for these criterion levels. Although the percentage of correct total classifications varies somewhat by criterion level and is relatively low, what is more important is the percentage of correct selections and rejections. These percentages change dramatically with the

Table 1

Summary of Results for M-70 Included Selection Model

	Calculation Case (N=209)				Validation Case (N=98)		
Criterion Level	% Variance Explained	% Total Correct	% Correct Selections	% Correct Rejections	% Total Correct	% Correct Selections	% Correct Rejections
1500 + (Expert)	26.9%	78.9%	48%	94%	71.4%	38%	89%
1300 + (First Class)	21.6%	71.8%	82%	57%	70.4%	81%	54%
1100 + (Second Class)	20.7%	78.5%	94%	34%	79.6%	93%	38%

Table 2

Significant Discriminating Variables by Rank for Selected Criterion Levels
(M-70 Included Model)

Rank	1500+ (Expert) Variables	1300+ (1st Class) Variables	1100+ (2nd Class) Variables
1	Tracking @ 25 MR/sec	Arm Length	Arm Length
2	Tracking @ 5 MR/sec	Tracking @ 5 MR/sec	Tracking @ 25 MR/sec
3	GM score	CO score	Height
4	Prior sports participation	Tracking @ 25 MR/sec	Eye Color
5	PT score	Height	Smoking
6	Eye Color	Prior sports participation	PT Score
7	Handedness		Prior sports participation
8	Right Eye Acuity		
9	Height		
10	Age		

criterion level and in reverse relationship. Thus, for the Validation case, the percent of correct selections goes from 38% at the Expert criterion to 93% at the Second Class criterion, while the percent correct rejections goes from 89% at the Expert level to only 38% at the Second Class level. These percentages of correct selection, in particular, indicate a fair degree of success of this model for predicting success in training. This is directly implied by comparing these correct selections with the observed training success performance obtained in the TOW Training program at the time of the data collection. During early 1977, when these data were collected, approximately 20% or less of trainees were qualifying as Expert and about 80% were qualifying as Second Class Gunners or better. These percentages were demonstrated by the actual qualification scores of the 307 cases in this sample as well. If this sample had been selected using the model developed, only about 80% of the trainees would have continued in training, but of those about 38% would have qualified as Expert and about 93% would have qualified as Second Class or better Gunners.

M-70 Excluded Model Results. Again detailed results are presented later. Table 3 summarizes the results of selection by a model which does not include the initial M-70 training scores. Again, the results are shown only for the criterion levels related to the M-70 qualification levels used at the time of data collection. Table 4 lists the significantly discriminating variables for each of the three criterion levels. From the percentages for correct selections shown in Table 3, it can be seen that application of this model would also have contributed to a higher percentage of selected trainees qualifying at each level. For the expert level, 27% of the selected trainees successfully qualified at that level compared with 20% in the non-selected total group. Similarly, for qualification at the Second Class level or better the selected group would have provided about 91% qualifiers as opposed to an actual level of about 80% for the non-selected total group.

Selection/Prediction for Live Fire Success

In assessing live fire performance during the TCATA TOW TEA test, two major MOEs were used: actual hit/miss of the target and radial miss distance measured from the center of mass of the target (RDCM). To develop the selection model it was necessary to choose one of these two measures as the basic criterion measure. TCATA used RDCM in the preliminary analysis of selection factors reported (TCATA report, pp. 2-23 thru 2-32). There appeared to be equally strong reasons for the use of either criterion, so both were investigated.

Initial correlation and multiple regression analyses were run to examine the interrelationship of RDCM and hit/miss and their relationships to the available predictor data. Table 5 shows that the initial multiple regression to predict RDCM yielded an $R = .578$. This value indicates that all predictor variables taken together can account for about 33% of the variance in RDCM. The similar regression for prediction of hit/miss scores yielded an $R = .481$.

Table 3

Summary of Results for M-70 Excluded Selection Model

Criterion Level	Calculation Case (N=209)				Validation Case (N=98)		
	% Variance Explained	% Total Correct	% Correct Selections	% Correct Rejections	% Total Correct	% Correct Selections	% Correct Rejections
1500 + (Expert)	13.3%	70.3%	38%	92%	62.2%	27%	84%
1300 + (First Class)	15.5%	64.1%	78%	48%	57.1%	72%	39%
1100 + (Second Class)	19.5%	79.4%	94%	35%	78.6%	91%	33%

Table 4

Significant Discriminating Variables by Rank for Selected Criterion Levels
(M-70 Excluded Model)

Criterion Levels		
1500+ (Expert) Variables	1300+ (First Class) Variables	1100+ (Second Class) Variables
Prior sports participation	Arm Length	Arm Length
Eye Color	CO Score	CO Score
GM Score	Prior sports participation	Eye Color
Right Eye Acuity	Height	Height
Handedness	Eye Color	GM Score
PT Score	Smoking	Smoking
Height		Prior sports participation
Arm Length		PT Score

Table 5

Correlation and Regression Analyses
for RDCM and Hit/Miss Data

Multiple Regression:

Criterion	R	R^2
Hit/Miss	.481	.231
RDCM	.578	.334

Simple Correlation of Hit/Miss with RDCM	$r = .548$ ($n = 186$, $p < .01$)

This value indicates only about 23% of the variance in hit/miss can be predicted by the variables taken together. The simple intercorrelation of hit/miss scores with RDCM was found to be .548, indicating a fair degree of relationship, accounting for about 30% of the variance. However, this intercorrelation is not sufficiently high to allow the assumption of equivalence of the two criteria (MOE). Given this value and the essential aim of the TOW system: to hit the target, the hit/miss criterion was chosen as the basis for selection model development.

The development of the live fire selection models was based on the total set of available data. This included all 222 gunners firing in the TOW TEA test. All gunners were used, regardless of different training, because the TCATA analysis had shown no difference in performance (either pH or RDCM) as a function of the training program. As for the M-70 selection models, the initial models were developed on about 2/3ds of the group and then validated through classification of the remaining personnel. Two separate models were developed, one including the ASVAB aptitude scores and one without these scores.

Table 6 shows the results of application of these two models. It can be seen that neither selection model is very successful. The ASVAB model was most successful in accounting for 31.1% of the variance in the criterion with thirteen variables included. This model yielded 86.9% correct classifications (both correct selections and correct rejections) and provided for 88.3% correct selections in the calculation group. In the validation group, the model yielded only 82% correct classifications and 86.9% correct selections. The second model was even less successful, accounting for only 9.9% of the variance with three variables. Here, the correct classifications were 84.7% of the calculation group and 85.1% of the validation group. Correct selection of hitters was 85.1% for this model. Variables contributing significantly to these discriminant models are listed in Table 7.

These two models indicate there is little benefit to be gained from selecting personnel for TOW gunnery. This is a direct implication of the comparison of the percentage of correct selections with the percentage of the unselected gunners who actually hit the target. Overall, bout 84.4% of the gunners hit the target (based on 205 missiles, excluding system failures). The best percentage for correct selections with the models is 88.3%, for the thirteen variable selection model. This yields only 3.9% improvement in the hit ratio if the gunners had been preselected using this model. Using the second model, the gain would have been only 0.7% (85.1% - 84.4%).

M-70 Training Vs. Live Fire

The relationship of M-70 training performance to live fire performance and the significance of qualification scores were issues for examination in the TOW TEA Test. The TCATA analyses treated these questions for the 108 gunners taking part in the comparison test (the add-on Test, see Paras 2.4.7 and 2.4.8, pp. 2-34 thru 2-40, TCATA Report). These analyses indicated no

Table 6

Summary of Results for Live Fire Selection Models

Model	Calculation Group (N=137)				Validation Group (N=67)		
	% Variance Explained	% Total Correct	% Correct Selections	% Correct Rejections	% Total Correct	% Correct Selections	% Correct Rejections
Including ASVAB Scores	31.1%	86.9%	88.3%	66.7%	82%	86.9%	33.33%
Less ASVAB Scores	9.9%	84.7%	86.2%	50%	85.1%	85.1%	0.0%

Table 7

Significantly Discriminating Variables in Live Fire Selection Models in Order of Contribution

	Selection with ASVAB Scores	Selection without ASVAB Scores
1	GM Score	Left Eye Acuity
2	Left Eye Acuity	Right Eye Acuity
3	TG Sccre	Smoking
4	SC Score	
5	CO Score	
6	OF Score	
7	Shotgun Exp.	
8	Pistol Exp.	
9	Eye Color	
10	Smoking	
11	Months of Service	
12	Right Eye Acuity	
13	Wearing Corrective Lenses	

differences between dry tracking and tracking with the M-70 in terms of either RDCM or hit/miss results (pH) for the 108 soldiers. The conclusion was that use of the M-70 did not produce a significant improvement in gunner performance. The analyses also indicated little relationship between M-70 tracking performance and RDCM for the M-70 trained group. TCATA concluded here that: "a) The M-70 does not accurately predict gunner performance; and, b) the distinction between expert, first class, and second class gunners is meaningless."

The data TCATA bases these conclusions on are presented in the following extract from the TCATA report, p. 2-38:

TABLE 2-22. M70 SCORES VERSUS RDCM CORRELATIONS

Task	Mean Score	Mean RDCM (meters)	r-value[a]
	Group 5B (17 gunners)		
A	482	0.84	-0.62
B	738	0.84	-0.54
C	638	0.84	-0.42
Overall	--	--	-0.39
	Group 6B (16 gunners)		
A	572	1.52	-0.30
B	794	1.52	-0.53
C	734	1.52	-0.22
Overall	--	--	-0.40
	Group 7B (16 gunners)		
A	658	1.36	-0.13
B	817	1.36	-0.09
C	720	1.36	-0.17
Overall	--	--	-0.13

[a]The minus r-values show an inverse correlation; as scores increase over the sample, RDCM decreases.
(One change has been made in this table: the mean scores for Group 6B were reversed for Task A and Task C in the original; the above figures have been corrected.)

The high r-values reported by TCATA for Group 5B, Tasks A and B, and for Group 6B, Task B, were of concern to ARI. These three values reported above are significant at less than the .05 level, indicating a trend in increasing correlation between M-70 performance and RDCM as rougher roads are used for training and qualification. (Group 7B trained and qualified using a smooth road for the target vehicle; Group 6B trained on a rough

road, but qualified on a smooth road; while Group 5B was both trained and qualified with the vehicle using a rough road.) Were this trend found to be real, the question of M-70 value in training and qualification would have remained unresolved.

ARI reexamined this question by redoing the correlational analysis above and investigating the correlation of qualification scores with the Hit/Miss criterion. Table 8 shows these values.

Table 8

Correlations of M-70 Qualification with RDCM and Hit/Miss (Groups 5B, 6B, and 7B)

	r(QxRDCM)	r(QxHit/Miss)
Group 5B (17 Gunners)		
Task A	-.15	.20
Task B	-.53	-.23
Task C	-.42	.13
Group 6B (16 Gunners)		
Task A	-.30	.64
Task B	-.53	.62
Task C	-.22	.62
Group 7B (16 Gunners)		
Task A	-.12	-.24
Task B	-.08	-.18
Task C	-.16	-.20

One important difference from the TCATA reported data was found: the correlation between RDCM and qualification score for Group 5A, Task A, was found to be only -.15, as compared with a reported value of -.62. To resolve this contradiction, ARI rechecked the original individual data values in the TCATA report against our data base (TCATA's Table 2-6 gives live fire data and Table D-2-5 shows individual qualification scores.) No error was found in the data base, therefore, it is assumed that the TCATA value is a typographical error. The value shown in Table 8 is accurate.

The remaining data in Table 8 do not indicate any strong relation between M-70 qualification and either RDCM or Hit/Miss. The high and statistically significant correlations shown for Group 6B appear to be actually chance results, based on the very small number of gunners who missed (Group 5B, 1 of 18 missed; Group 6B, 2 of 16 missed; and, Group 7B, 2 of 16 missed.) The fact that such correlations do not appear for either 5B or 7B also indicates this is likely a statistical anomaly rather than real.

Based on these data, as corrected, there appears to be no real relationship between M-70 qualification scores and either RDCM or Hit/Miss with the live missile.

Discussion and Conclusions

The data and analyses summarized above indicate there is little to be gained from either selection of gunner trainees or use of the M-70 as a training device for gunner trainees. Although the development of selection models is possible, as shown previously, the application of these to the population (as represented by the gunners used in the TCATA test) provides only minimal increases in the hit probability for the selected groups. This implies that the costs of application of the selection techniques would outweigh the hit payoffs, since selection will yield very little benefit to the system performance.

With respect to the utility of the M-70 as a training device; the basic TCATA data show that essentially untrained gunners achieve hit probabilities nearly as high as those of fully trained gunners, using the M-70 feedback on tracking performance. These data indicate that the M-70 feedback provides very little training value above that provided by dry tracking with the TOW equipment alone.

As an evaluation device, the TCATA data show that the M-70 is totally inefficient: there is no indication of a predictive relationship between M-70 qualification scores and either live fire miss distance (RDCM) or live fire hit probability.

The following conclusions are drawn from the above analyses:

(1) Formal selection models should not be developed for TOW gunners. If informal selection methods are desired by field commanders, these should be very simple and based on the findings of this research. Such an informal procedure should consist of selecting as gunners those soldiers who have perfect vision (20/20 in both eyes and no other observed defects) and who are non-smokers. Such selection will maximize the probability that these gunners will hit targets, but the gain in probability is likely to be very small.

(2) Further use of the M-70 as a training device or as an evaluation tool should be carried out only if there are no costs associated with such use. Further developments or purchases of M-70 should be pursued only if such developments can be demonstrated, with empirical data, to have a measurable training benefit - a true contribution to hit performance.

(3) Criteria for elimination of trainees from TOW training can not be developed since live fire performance can not be predicted from training performance, given the measures available. This has become a trivial question given that trainees (no matter how trained) succeed at live fire with probabilities which closely approximate system performance specifications.

TECHNICAL SUPPLEMENT

BACKGROUND

This portion of the report presents the detailed development of the selection/placement models used to determine the feasibility of TOW gunner selection. It discusses the TOW and the training system used as well as early attempts at gunner selection for TOW and similar systems. It also describes preliminary research leading to the methods developed and applied in selection/prediction for the M-70 training situation and for the live firing of the TOW.

Training soldiers in the technique of anti-armor guided missile gunnery has uncovered difficulties unforeseen at the time the weapons were fielded. The primary difficulty is that insufficient soldiers were qualifying in anti-armor guided missile gunnery to fill the needs of the active Army. Further, in the TOW system, little has been known about the utility of the currently used TOW simulator, the M-70 trainer. Specifically it is not known whether or not the M-70 trains to increased probability of live-fire hit or whether it trains merely to itself as a criterion.

Several methods are available for increasing the numbers of soldiers qualified to operate tactical guided missiles. One method is to place in a training program (according to some set of criteria) those soldiers who possess characteristics which indicate a good probability of meeting or exceeding some minimal acceptable performance criterion after training. Ideally, a set of convenient measures could be used to place likely candidates in training programs and thus increase the number of qualifying soldiers produced from the training programs. A concomitant decrease in numbers of soldiers found to be unqualified after training should reduce training cost per qualified soldier.

Two assumptions must be borne in mind while reading this report. They are necessary to understanding the limits bounding the information presented herein. First, the placement models considered here must be referred to their underlying training programs and in a sense are operationally defined by these training programs. Second, the M-70 placement models and the live-fire placement model should not be equated as the former presupposes criteria which operationally and functionally differ from the latter. Succinctly, a soldier's performance in the M-70 training is not necessarily indicative of live-fire performance.

THE TOW SYSTEM

The TOW system is composed of three interactive elements. These are the weapon and training device, the program of instruction, and the gunner. Each will be described briefly.

The TOW is a heavy anti-armor weapon which fires a tube-launched, optically tracked, wire-guided missile. It is operated with a four-man crew: squad leader, gunner, assistant gunner, and vehicle driver. The TOW hardware consists of a tripod, a traversing unit, a missile guidance unit, a battery set, the TOW round (packed in an integral launch tube), and a tracking unit which incorporates an optical sight. An infrared (IR) receiver assembly in the tracker receives a signal from an infrared flare in the after end of the fired missile. The tracker electronically compares the missile position with the gunner's line of sight. The resulting error signals are translated to steering commands. These signals, transmitted through the tracking wire, control the missile's steering vanes during flight. Effective range is 65-3000 meters. The ground-mounted TOW is usually fired from the kneeling position. The tripod provides a three-point support platform for the system.

THE TRAINING SYSTEM

The primary training device for the TOW is the M-70 trainer. The M-70 was adopted because of the great cost per round of both armed and inert TOW missiles. The trainer consist of an instructor console, a remote IR source tracking target, and a missile simulator round which are used with the TOW launcher assembly. The trainer provides practice with feedback on the gunner's performance in tracking the IR target source. It does this by measuring and recording the soldier's tracking deviations in azimuth and elevation as his line of sight is compared to the actual position of the infrared (IR-source) target. A weighted mean deviation in azimuth and elevation is computed and reported as "percentage of time on target" for each tracking trial. A deviation from the simulated tracking envelope, i.e., exceeding designed tracking limits, terminates the trial and is reported as a "launch excursion."

The M-70 can be fitted with an M-80 blast simulator diaphragm. This produces an explosion designed to simulate gryroscopic activation and ignition of the TOW missile. The M-80 also provides an approximate 1.5 second delay between trigger press and ignition, which is the same as for the TOW missile. Target ranges are simulated for training with the M-70 by varying target velocities at constant ranges and/or by varying both tracking times and velocities to simulate various missile flights.

The TOW program of instruction (POI) provides instruction in assembly, maintenance, deployment, firing, target tracking, and safety. The institutional course defined by TC 23-24 consists of 39.5 hours of

instruction distributed over 5 days and has been reviewed and analyzed elsewhere (Maxey, 1977). As other POI are derived from this institutional program, a summary of it will be useful for understanding the models and analyses which follows. Training in simulated firing and tracking of targets in this POI is done with the M-70 training system. Day One requires 36 tracking runs at near and far simulated ranges. Target speeds vary from zero to 25 MPH. At the range used, this approximates tracking at angular rates of zero to 25 milliradians per second (MR/sec). Trials are distributed in left-to-right and right-to-left fashion. Day Two requires tracking similar to Day One with the inclusion of a "stop and go" tracking exercise. A total of 39 trials is run on Day Two. Day Three is similar to Day One. Day Four requires night tracking and the tracking of short- and long range targets. Also included in Day Four is a rapid firing exercise. Day Five requires qualification firing, also using the M-70 system.

To qualify, the trainee fires simulated rounds in the M-70 fitted with the M-80 blast simulator diaphragm. Ten simulated rounds each are fired at tracking rates of 5, 15, and 25, MR/sec, equally distributed in right-to-left and left-to-right tracks. Of one thousand possible points per tracking task (10 trials with a maximum of 100% time-on-target per trial), the gunner must have 550 points each in the 5 and 25 MR/sec tasks and 750 points on the 15 MR/sec task in order to qualify. The score on the lowest-ranking task is equated to an overall qualification rating of "Expert," "1st Class," "2d Class," or "unqualified" to the trainee. In all cases in training and qualification, an incomplete track or "launch excursion" is scored as zero.

The TOW gunner qualifies in the current POI based on his tracking ability as measured by the M-70. In the M-70 system, the gunner's hands guide the TOW launch tube in azimuth and elevation by direct linked viscous damped controls. The launcher holds the optical sight and tracking receiver, measurement of the error angle (defined by comparison of the line of sight to the IR-source position) produces an error signal. This error signal is averaged and at the end of the simulated flight is displayed for the gunner. Hence, to qualify the gunner must exercise a great deal of motor control over the launcher so that he can keep the sight reticle at the center of visual mass of the target. This requires gross and fine visuomotor adjustments. Figure 1 shows the gunner in the kneeling firing position. As suggested by this figure, both trunk and extremity visuomotor control are necessary parts of the TOW tracking task.

PREDICTION OF MISSILE GUNNER

When the TOW hardware and training system were developed, no detailed task analyses were performed to define the Gunner's task and the required skills and capabilities. The M-70 was developed to reproduce as faithfully as possible the characteristics of the actual TOW system performance, based on the best information and assumptions of the designer. The M-70

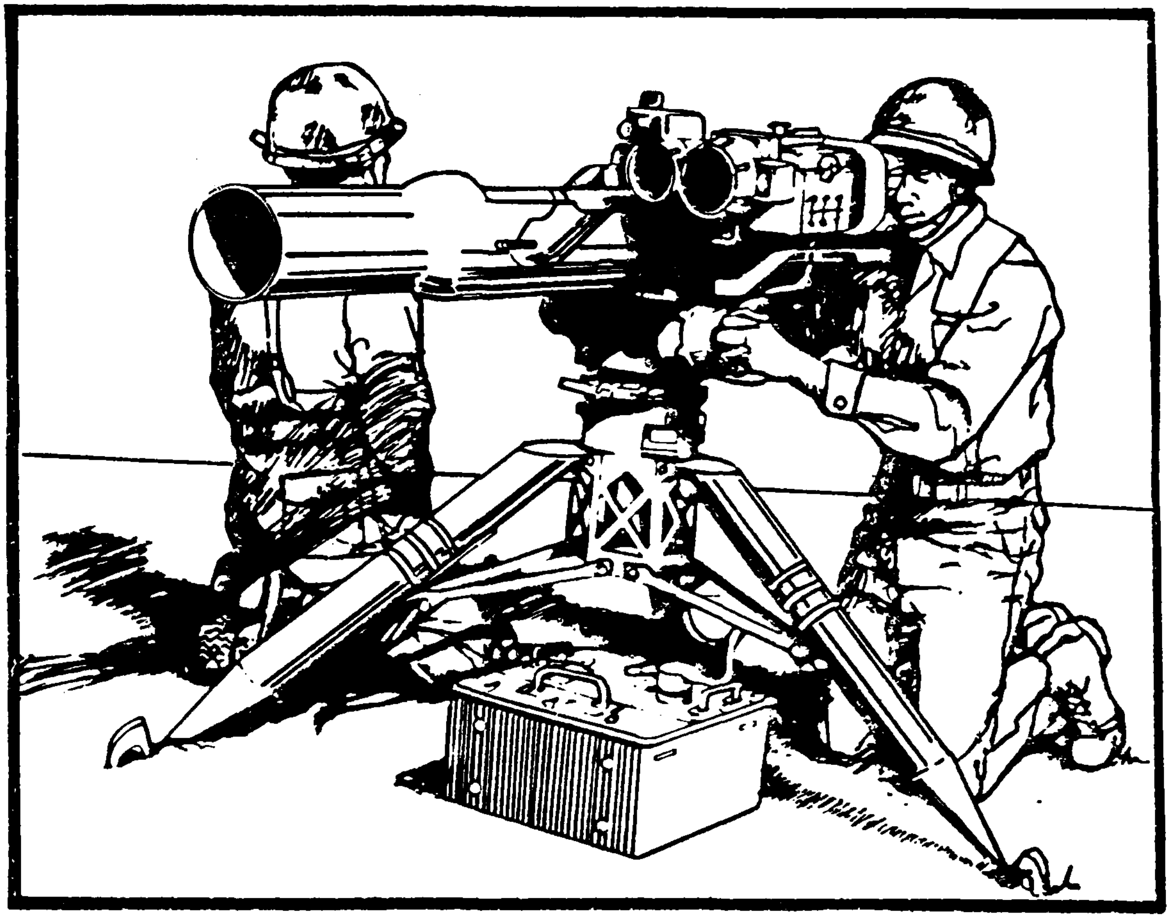

Figure 1

was not in fact designed to be a training system but for other purposes. The US Army then chose to adopt the M-70 as the best available approximation to a trainer because it did allow tracking practice without the high cost of the TOW round. The POI for TOW was then adopted from the POI of a medium antitank guided missile, the Dragon.

No significant attempts have been made to predict soldiers' performance either on the M-70 system or in live fire. A few attempts have been informally reported which made use of doubtful methods - and small numbers. Several attempts, however, have been made to predict Dragon performance on the Launch Effects Trainer, the Dragon Trainer. The pertinent literature is reviewed below.

Stewart, Christie, and Jacobs (1974) attempted to predict performance on the Dragon Launch Effects Trainer (LET). Using soldiers (N = 125), they took motor, visual, visuomotor coordination, personality, and intelligence measures. In all, 32 independent measurements per subject were obtained. These 32 variables were selected by a task analysis procedure and by ratings from "subject-matter experts." Dependent measures were summed qualification scores for each tracking task, including night tracking. Dragon LET qualification scoring is highly similar to that of TOW M-70 scoring.

Six variables were found to account for 36.5% of the criterion variance when all independent variables were regressed in a forward stepwise fashion. The most predictive of these six variables accounted for about 25% of the variance, the least predictive for about 1%. Of these six predictors, four were measures of visuomotor coordination, one was a confidence measure, and one was the meter scores obtained by gunners with the LET during stationary familiarization firings. The last variable accounted for about 4% of the criterion variance, whereas the visuomotor coordination measures (taken together) accounted for about 30% of the variance. The number of hits made in LET familiarization firings accounted for only about 1% of the criterion variance. Measures of visual ability and measures of aptitude accounted for no more than about 1% each of the criterion variance.

The Stewart, et. al., study is of interest because characteristics found measurable by a well-known pursuit-tracking device (Fleishman, 1958; Fleishman and Hempel, 1955, 1956) were fairly predictive. Both the first-ranking predictor "average time on target per trial (rate control)" and the fourth-ranking predictor "number of times on target (rate control)," were measured by this device. Moreover, neither purely visual or purely motor tasks (i.e., motor tasks without visual control) accounted for much of the criterion variance.

Cartner and Tierney in an unpublished pilot study found several relationships which expand the findings of Stewart, et. al. They performed analyses on four sets of data collected from Dragon trainees at Fort Polk, LA., Fort Benning, GA., and during Dragon Operational Test III-A (OT III-A).

In the first analysis, data from Dragon training, collected early in the POI, were correlated with hit-miss data from the qualification tasks of the POI (N = 68). Scores from the first day of training accounted for 31% of the variance in qualification scores. Scores from the first half of training accounted for 35% of the variance of qualification measures, the additional 1 ½ days of training adding only 4% to the explained variance. After three days of training, 39% of the variance in qualification scores was explained by scores from the third day of training (an additional 4%). Hence, only 8% additional variance was accountable by the two days of training beyond the first day.

Applying the current institutional POI (TC 24-20) minimum qualification standard of 70% LET-measured "hits" per tracking task (or the minimally qualified "second class" gunner standard), Cartner and Tierney found 50% of the trainees in this study were attaining the minimum standard on all tasks after the first day of training, 41% after the first half of training, and 57% after three days of training. At the end of training 71% qualified.

In another analysis, Dragon instructors and trainees were interviewed. Based on these interviews and the pursuit tracking literature, a list of variables in three categories was devised. These categories contained background, anthropometric, and tracking performance measures. Specific variables measured included ocular dominance, handedness, eye color, frequency of smoking behavior, height, weight, arm length, visual acuity, lateral and vertical phoria, shoulder width, and first-day-of-training performance. Measuring a sample (N = 37)of soldiers from Fort Benning Dragon classes, these data were regressed in stepwise fashion against summed qualification scores.

Scores from the first day of performance on the LET accounted for 29% of the variance in criterion scores. An additional 6% of the variance was attributable to arm length which increased the multiple correlation coefficient from $\underline{R} = .54$, to $\underline{R} = .59$. Adding height and weight to the regression equation increased the amount of criterion variance explained to 41% ($\underline{R} = .64$, $p < .01$). The addition of eye color, hand and eye dominance, frequency of smoking behavior, and shoulder width (in that order) increased the multiple correlation coefficient to $\underline{R} = .65$ ($p < .01$), a trivial increment.

A third analysis was performed on data from a group of 27 Fort Benning soldiers. The best set of predictors of qualification were (in order) tracking performance on the first day of training, arm length, acuity of the right eye, height, weight, vertical phoria, lateral phoria, and acuity of the left eye. Again performance scores on the first day of LET training and arm length accounted for some 36% of the variance in qualification scores.

It would appear then, that some classes of variables are reasonably predictive of a trainees' performance on the LET. As Stewart, et. al., found, performance on the pursuit tracking device predicts to a certain extent performance on the LET. Further, the Stewart, et. al., analyses suggest that early performance on the LET predicts to a certain extent subsequent performance on the LET.

The LET-predicting-LET finding was substantiated by Cartner and Tierney's findings. Further Cartner and Tierney found that anthropometric differences may account for some criterion score variance.

Cartner and Tierney additionally then analyzed data from Dragon OT III-A. Looking at variables concomitant to Dragon live-fire, some "no difference" findings were of considerable interest. For example, the probability of hitting targets was not affected by the position of the firer (standing, sitting, or kneeling), the type of target (tank, armored personnel carrier, or bunker), the target orientation (frontal, lateral, or oblique), or the range of engagement (near or far).

Cartner and Tierney have adapted and expanded the methods used for LET performance prediction (Stewart, et. al., 1974) to M70 performance predictions. They analyzed a set of data collected from TOW trainees (N = 87) at Fort Polk, LA. All soldiers received four days of training according to the TOW POI. Qualification trials were made on the last day of training.

Performance on the M70 on the first day of training was found generally to be a good predictor of qualification trials performance. Specifically, first day performance on the 5 MR/sec tracking task accounted for 23% of the variance in qualification performance of the 5 MR/sec task, ($p \leq .01$); 11% of the variance in the 15 MR/sec task ($p \leq .01$); and 25% of the variation in the 25 MR/sec task ($p \leq .01$). For the other tasks, first day performance did not predict any later qualification tasks.

After three days of training, performance on the 5 MR/sec task explained 37% of the variance ($p \leq .001$) in the 5 MR/sec qualification task; 30% of the variance in the 15 MR/sec qualification task ($p \leq .001$) and 37% of the variance in the 25 MR/sec qualification task ($p \leq .001$). The 15 MR/sec task explained 32%, and 46%, respectively, of the 5 MR/sec and 25 MR/sec qualification tasks ($p \leq .001$). Performance on the third day in the 25 MR/sec task explained 16%, ($p \leq .01$), 7% ($p \leq .05$), and 15% ($p \leq .01$) respectively of qualification in the 5 MR/sec, 15 MR/sec, and 25 MR/sec tracking tasks.

Based on these preliminary attempts at gunner prediction and selection, the present study was designed. Briefly, this research is directed toward a definitive examination of the feasibility of selecting TOW gunners. The research was directed first toward selection of trainee based on prediction of training success using the M-70. The second stage in selection research was directed toward selection of gunners based on success in live fire. The latter research was to be performed using data derived from a field test of TOW training effectiveness during early 1978 at the TRADOC Combined Arms Test Activity (TCATA).

METHOD

The following sections address the methods followed in each of the selection model developments. The first addresses the development of two M-70 placement models. The second addresses development of the TOW live-fire model.

SELECTION FOR TOW TRAINING

Data collected were arranged in a Subjects X Measurements format to facilitate multivariate statistical manipulation.Relevant data were a set of predictor measures for each subject and a set of criterion measures for each subject. Data were collected from mid-January to mid-April 1977 in three simultaneous operations. One operation involved measuring performance on the M-70 trainer during training and qualification. A second operation recorded pertinent background data from each soldier's Official Record Jacket (DA 205). A third operation involved the measurement of each soldier along various dimensions prior to training on the M-70.

Subjects. Subjects (N = 307) were male, late-adolescent soldiers of the 1st Advanced Individual Training Brigade (Infantry) at Fort Benning, Georgia. Soldiers were not randomly assigned to TOW training. Selection for guided missile training was based on the soldier's post-AIT assignment. If to be assigned to USAREUR where TOW is available, the soldier went to TOW training. This procedure, while not random is sufficiently haphazard to warrant treatment of the sample as a randomly selected group. Soldiers from 14 TOW classes were measured. Class sizes ranged from 7 to 31 trainees (median = 23). Data from 13 subjects were discarded due to incomplete or uninterpretable records.

Performance Measurements. The performance measurements were M-70 meter readings at the termination of tracking, 0 MR/sec, 5 MR/sec, 15 MR/sec, and 25 MR/sec targets. Scores were recorded for each subject in his first four attempts to track targets with the M-70 in each task. Scores were subsequently recorded for the last four qualification trials at each rate. Thus, measurements assessed the goodness of track for the first four and the last four attempts of each subject at each tracking task. M-70 measures were recorded at firing ranges by a trained noncommissioned officer immediately after each tracking trial.

Background and Other Measurements. Twenty (20) items of background data were recorded from each subject's Official Record Jacket (DA 205). These included age, complexion (light or dark), height, weight, last physical training test score, handedness, years of education, whether corrective lenses were worn, months of military service, M16A1 rifle qualification, prior participation in contact and noncontact sports, and composite scores of the Armed Services Vocational Aptitude Battery (ASVAB).

(General Technical (GT), general mechanical (GM), electrical (EL), clerical (CL), motor maintenance (MM), surveillance and communications (SC), combat (CO), field artillery (FA), scientific and technical (ST), and operator and food service (OF) aptitude scores were collected.)

Other measurements were made prior to TOW training by personnel trained in these measurement techniques. These included each trainee's shoulder width, arm length, ocular dominance, reported smoking behavior, visual acuity, visual phoria, and eye color (light or dark).

Background data were collected in conformity with the Privacy Act of 1974 and under 10 USC 8012 and 5 USC 301. These data were drawn from each soldier's Official Record Jacket by persons regularly assigned to the Adjutant General of the Infantry Center, Fort Benning, Georgia.

The above variables were selected because of demonstrated utility in prior studies or because of indications from the psychological literature that they might be predictive. A third group of variables was included because of ease of measurement. The last consideration was a determining factor in the inclusion/exclusion for each independent variable as one of the purposes of this study was to identify readily measurable quantities useful to the decision-maker in the field. This person would be responsible for applying any feasible placement model developed from this study. Variables fell into several convenient classes of anthropometry, measures of M-70 performance, demography, self-reported background items, measures of aptitudes and measures of training performance and conditions.

Analytic Technique

The data were subjected to preliminary reduction prior to development of the selection models through discriminant analysis. Certain variables were known _a priori_ to have high intercorrelations. Thus, correlation coefficient matrices were calculated for anthropometric, visual, and ASVAB score variables. Only one of a pair of variables correlating $p \pm .75$ were maintained. For example, 15 MR/sec tracking correlated highly with 5 MR/sec and 25 MR/sec tracking (training and qualification), this variable was deleted.

The qualification tracking scores for all subjects were taken as the criterion variables for the regression and discrimination analyses. Tracking scores at qualification for the 5 MR/sec and 25 MR/sec tasks were added for each subject to establish his criterion score.

Eight arbitrary criterion levels were established against which to discriminate. These were a combined score on Tasks A and C of 1) 1650 or better; 2) 1500 or better; 3) 1430 or better; 4) 1370 or better; 5) 1300 or better; 6) 1230 or better; 7) 1170 or better; and, 8) 1100 or better. Criterion levels 2), 5) and 8) were determined by adding the minimum current qualification scores for Tasks A and C for Expert, First Class, and Second Class Gunners, respectively (adding the 5 MR/sec and 25 MR/sec qualification levels). Intermediate values were established by linear interpolation.

Discriminant analysis was performed using data from 209 cases randomly selected from the 307 available.* No Bayesian corrections were made for class inclusion. The equations derived from the discriminant analysis were then applied to the remaining data collected from the 98 other subjects. A stepwise discriminant paradigm was employed; inclusion/exclusion criterion was set F = 1.00. Only one discriminant function per criterion level was calculated. Although the intended use for a model such as this appears to be "select out" persons prior to TOW/M-70 training, classification function coefficients were observed for both the "Go" and "No Go" groups. Additionally, standardized and unstandardized discriminant function coefficients were calculated.

Two training selection models were constructed. The first includes M-70 training scores (the mean of the first four training trials on the 5 MR/sec and 25 MR/sec tasks) as discriminating variables. The second model excludes these M-70 scores, using only variables other than M-70 measurements as discriminants.

SELECTION FOR LIVE FIRE PERFORMANCE

Data for the development of the live fire model were obtained during the conduct of a TRADOC Combined Arms Test Activity (TCATA) test of TOW training effectiveness at Fort Hood, TX, from March to June of 1978. This test, sponsored by the Infantry School (USAIS), has been reported in detail by TCATA and will not be detailed here.** This discussion will cover only the data collection and analyses necessary to the examination of the selection model.

Subjects and Training. Three groups of gunners were trained under three different training programs in the TCATA test. Group I (N=114) was trained on a minimum program consisting of 6.5 hrs. of miscellaneous TOW subjects (fundamentals of operation, maintenance, safety, target identification, etc.) and 1.5 hours of tracking practice in a crew of three, giving only ½ hour of hands-on dry (without feedback) tracking per person. This consisted of ten trials of the 5 MR/sec Task A.

The test initially intended to compare the performance of this group with that obtained by two groups to be trained later with 14 hours (medium program) and 39 hours (maximum program) of training. The latter two groups were to have used the M-70 trainer in tracking practice. However, performance in live fire by the minimally trained Group I personnel was sufficiently good that TCATA and TRADOC determined the latter two groups unnecessary. A substitute test comparison was developed to help determine the effectiveness of M-70 training on TOW live fire performance. This was called the "Add-on Test" by TCATA and is reported as such. The "Add-on"

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*The discriminant program from the Statistical Package for the Social Sciences (SPSS) Version 6.2 was used for all discriminant analysis.

**Training Effectiveness Analysis (TEA)-TOW Part I, Hq, TCATA, Fort Hood, TX, Sept 78.

test groups were trained and fired and these data were available for use in this analysis.

The "Add-on" test subjects were divided into two additional groups. Group II (N=54) and Group III (N=54) each received about 20 total hours of TOW instruction. This included the fundamentals training received by the Group I personnel, and about 12 hours of tracking experience, with 4 hours as gunner and 8 hours as a crewmember for each soldier. Group II tracking training used the TOW with the M-70 trainer so each gunner received feedback on his performance after each trial. Group III training used the TOW without the M-70 tracking non-infrared targets, and the gunner received no feedback on the quality of his tracking for any trials. Approximately 120 tracking trials were performed by each gunner in both Groups II and III. For Group II, these were distributed as 80 trials on the 5MR/sec Task A and 20 trials on each of the 15 MR/sec Task B and the 25 MR/sec Task C. Group III trainees performed 80 dry tracking trials on the 5 MR/sec Task A and 40 on the 15 MR/sec Task B.

Predictor Measures. All demographic, aptitude, anthropometric and self-report data collected during the development of the training-selection model, indicated above, were also collected for each subject involved in this test. Additionally, several behavioral measures were collected and detailed attitude and expectation questionnaires were designed to be administered before training, after training and after live fire. Behavioral measures taken were two scores derived from standard trials on a standard pursuit rotor device (time on target and number of errors) and a steadiness test. The questionnaires developed by ARI were administered only to the Group I trainees. TCATA determined that, since the "Add-on" test groups were not part of the original experiment, these data for Groups II and III were irrelevant. Appendix A lists the predictor measures collected in this part of the research.

Performance Measurements - M-70. Performance measures were obtained for each subject in all three groups. For Groups I and III these were collected after live fire. Group II data were collected during training. Data collected were records of the M-70 meter scores and strip chart recordings of the azimuth and elevation error signals generated during tracks by the M-70 tracker. M-70 meter scores were obtained for each man on his initial ten tracks with the M-70 trainer on the 5 MR/sec Task A. Strip chart recordings were collected only for the first and final tracks of each man at each Task, regardless of Group. M-70 meter scores were to be used to determine the relation of current scoring to live fire measures described below. Tracking error data were to be correlated with tracking data collected during the flight of the actual missile in live fire. Due to TCATA Test Director decision during the test, there was an anomaly in the data collection process for Group II. This resulted in the three subgroups (5B, 6B, and 7B in TCATA's designation) being trained and qualified under different conditions (smooth tracking roads vs. rough grassy tracking roads).* Preliminary analyses of these data by TCATA indicate that the

*See TCATA report, Para 2.4.8, pp. 2-36 thru 2-40, and Appendix E.

resulting M-70 tracking scores are sufficiently different for the three subgroups to preclude certain detailed analyses of the data.

Performance Measurements - Live Fire. Live fire data were collected by TCATA for each missile firing. The details of the firing environment and the data collection procedures are presented in the TCATA report (Para 2.3 Execution, and especially pp. 2-9 through 2-12). Briefly, each gunner was presented with a field situation and directed to engage a specified M47 Tank target following a relatively smooth road at a speed of 12-15 mph and a range of from 2,950 to 2,750 meters. During the engagement, flight data were collected with video tape recorders. One camera was mounted on the TOW optical tracker (aligned generally with the optics), and a second camera was located down range to cover the target. Tapes from these cameras were analyzed, by single frames, to extract error measures. The first camera tape yielded deviations of the line of sight from the target center of mass during missile flight. The second, covering the target, allowed measurement of the radial miss distance from center of mass as the missile crossed the target plane (RDCM). In addition to the RDCM measure, the actual values of azimuth and elevation errors at the impact plane were recorded. Reduction was accomplished by TCATA personnel and the report indicates these measures were accurate to $\pm$ .25 meter. Actual hit or miss of the observed round was verified through this analysis also, and the result was recorded for each gunner.

The deviation errors during the flight were recorded for use in subsequent comparative analyses with the tracking errors recorded on strip charts during tracking with the M-70 trainer. These were to be used in analysis of the relationship between M-70 tracking and live fire tracking. These latter analyses were not performed, based on the results reported later.

Analytic Technique

Analysis of the live fire data and the use of regression and discriminant analysis to predict live fire success was largely parallel to the analysis described earlier for the prediction of the M-70 training success. One additional requirement necessary here was the determination of the most appropriate criterion measure for prediction. The TCATA test staff collected data on both the radial miss distance from the center of mass (RDCM) and the hit/miss success of each gunner. Both measures of effectiveness (MOEs) have some degree of face validity and could be useful criteria for successful performance. Thus, it was necessary to evaluate the goodness of these two alternative criteria for prediction. This was accomplished by assessing the relationship between the two and the degree of multiple relationship between the predictor variables and each criterion measure. Simple correlation of the two values for the gunners with available data (N=186) resulted in an $r = .548$, indicating that either criterion would account for about 30% of the variance in the other. This value is relatively

high but not sufficiently high to assume equivalence between the two measures. Multiple regression was used to examine the relationships of all predictor variables to the two MOE and these resulted in R = .481 for hit/miss scores and R = .578 for RDCM values. These equate to prediction of about 23% of the variance in hit/miss and about 33% of the variance in RDCM values. Although the predictive value is higher for the RDCM measure than for hit/miss, two facts directed the choice of hit/miss as the final criterion for use in prediction/selection model development: 1) actually hitting the target is the ultimate measure of whether a gunner is good or not, since that is the point of target engagement. Although it could be argued that a nearer hit is better than a peripheral hit, it can also be argued that the center of mass is not necessarily the best of all places to hit a tank (e.g. - a motor hit or a turret hit might be considered more effective than a center of mass hit - although the difference is probably negligible); and, 2) of the total of 222 gunners in the TCATA test who fired missiles, RDCM was available for only 193. Use of this as the criterion would thus result in lowering the total N by 29 gunners. Based on both these considerations, the hit/miss result was determined to be the more appropriate criterion for development of the prediction/selection model.

The total set of 222 gunners for whom data were available were used for development and validation of the discriminant models. The aggregation of the three groups into a single set was based on the finding by TCATA that the different training programs had no statistically differential effects on the hit probability of the different trainees. For these purposes, the groups performed nearly identically, thus they were aggregated into a single data base for prediction/selection model development. Discriminant analyses were then run using the full set of prediction variables to attempt to differentiate between hitters and missers. The analysis used 2/3rds of the gunners to develop the prediction model (the calculation case) and used the remaining third of the gunners to assess the validity of the discriminant function so developed. After initial runs, non-discriminating variables were discarded and two sets of predictive variables were chosen based on the initial discriminant scores and the classification scores assigned. One set included the scores from the Armed Services Vocational Aptitude Battery (ASVAB) while the second set did not include these scores. Final discriminant runs were made with these reduced variable sets. The results are reported below.

RESULTS

This section presents separately the results of the two separate prediction/selection efforts: that to predict/select TOW gunners to be successful in training on the M-70 device; and, that to predict/select gunners for successful performance on the live firing of the TOW system.

THE M-70 MODELS

Two models were developed to select trainees for entry into M-70 training for TOW gunnery: The first included initial TOW performance as a predictor variable together with the anthropometric, demographic and behavioral variables listed in Appendix A; the second used only the variables available prior to any TOW training.

Prediction of Training Success with M-70 Performance Included

Discriminant analyses were performed as described in the Analytic Technique above. The computer outputs of the multiple runs against each of the eight criterion levels used (Cf. p24) are presented as Tables B1 - B8a in Appendix B. These tables include the order of entry of the variables into the analyses, the standardized and unstandardized discriminant scores, and the classification function scores for each analysis, and the centroid values for each of the "GO" and "NO GO" groups. The "GO" group was defined prior to each analysis as that portion of the calculation group who actually attained a score on Tasks A and C combined equal to or exceeding the criterion value.

Table 8 shows the set of variables found to be significant discriminators for each criterion level in the calculation group. These are listed in the order of contribution to the discrimination of the two groups, based on the standardized discriminant scores. As seen, the variables found to discriminate vary somewhat at each criterion level. However, the initial M-70 tracking performance on both the 5 MR/sec and 25 MR/sec tasks, arm length, eye color, height, and either GM score or CO score (both from the ASVAB) tend to be involved in most predictive sets.

Table 9 presents a summary of the results of the discriminant models by criterion level. It will be seen that these models account for a minimum of 20.7% of the variance in final M-70 performance at the minimum criterion level for the calculation case. Variance accounted for ranges up to 26.9% for the prediction of the criterion equivalent to the then-current Expert performance on Tasks A and C combined. This table also shows the degree of success of each model for both the calculation case and the validation case (application of the models to the classification of the hold out group: (N=98)). The first comparison is between the percent of total correct classifications. The second column under the calculation case and the first column under the validation case give this comparison. It can be seen that these percentages range from 70% to about 82% for the calculation case and fall only to 59% to 79% for the validation case, thus indicating some consistency of the models in transfer to the validation case. However, it should also be noted that the 82% high value for the calculation case is not especially high. Going to the next column to the right for both cases allows comparison of the percentage of correct selections given by each model. Here it is important to note that the percentage of correct selections varies inversely with the criterion level

Table 8

Discriminating Variables by Rank and Criterion Level
for M-70 Included Model

Rank	1650 or Better	1500+	1430+	1370+
1	Eye Color	Trng 25 MR Score	Trng 5 MR Score	Trng 25 MR Score
2	Trng 5 MR Score	Trng 5 MR Score	GM Score	Arm Length
3	Trng 25 MR Score	GM Score	Trng 25 MR Score	GM Score
6	Smoking	Prior Sports Participation	Eye Color	CO Score
5	PT Score	PT Score	Arm Length	Trng 5 MR Score
6	Height	Eye Color	CO Score	Height
7	Rt Eye Acuity	Handedness	PT Score	Eye Color
8		Rt Eye Acuity		
9		Height		
10		Age		

Rank	1300+	1230+	1170+	1100+
1	Arm Length	Arm Length	Arm Length	Arm Length
2	Trng 5 MR Score	Trng 25 MR Score	Trng 25 MR Score	Trng 25 MR Score
3	CO Score	Eye Color	Height	Height
4	Trng 25 MR Score	Height	Eye Color	Eye Color
5	Height	Prior Sports Participation	CO Score	Smoking
6	Prior Sports Participation	PT Score	GM Score	PT Score
7		Age	PT Score	Prior Sports Participation
8		Smoking	Prior Sports Participation	
9			Smoking	

Table 9

Summary of Results for M-70 Included Model
(For all Eight Criterion Levels)

		Calculation Case (N=209)			Validation Case (N=98)		
Criterion Level	% Variance Explained	% Total Correct	% Correct Selections	% Correct Rejections	% Total Correct	% Correct Selections	% Correct Rejections
1650 or better	15.7	81.8	20	98	77.5	20	97
1500+ (Expert)	26.9	78.9	48	94	71.4	38	89
1430+	21.6	73.7	62	84	70.4	57	78
1370+	25.9	70.8	70	71	59.2	58	61
1300+ (1st Class)	21.6	71.8	82	57	70.4	81	54
1230+	25.4	73.7	89	47	72.5	90	55
1170+	24.4	73.7	92	38	69.1	93	46
1100+ (2nd Class)	20.7	78.5	94	34	79.6	93	38

predicted. This is true for both the calculation case and the validation case. Conversely, the percentages of correction rejections (the last column in each set) varies directly with the level of the criterion predicted. The percent correct selections is simply the percent of those predicted by the model to be GO on the criterion level who actually were observed to be GO on the measured criterion. Similarly, the percent correct rejections is the percent of those predicted to be NO GO who were so observed in measurements. Thus these values are direct measures of the efficiency of the model in either selecting trainees "into" or "out of" the training program. For example if the highest criterion level were used, and the validation case trainees were examined for actual selection for training, this model would have correctly rejected 97% of those who would not have performed on the M-70 at this criterion level. However, it would have selected into training a group, of which only 20% would have passed the criterion level. It also should be noted that this model and criterion level would only have selected about five gunners of the 98 for training. Thus, this model is very stringent and exclusive rather than inclusive. Conversely, if the lowest criterion were to be used for selecting from the validation group those who should be trained, 93% of those selected would have passed the criterion, while only 38% of those rejected would actually have been failures if trained. This model would have selected about 74 of the 98 for training and thus would have yielded 69 successful trainees. This, then, with the lower criterion level, yields a more inclusive model and a much higher successful inclusion rate. It should be noted that the 93% successful selection rate exceeds the rate that was prevalent in TOW training at Fort Benning at the time these data were collected - the then-current success rate (2nd Class or better - equals 1100+) was about 80%. It should also be noted that this rate was since sharply increased through differential training developments by the Weapons Group within USAIS. Recent success rates have exceeded 90% consistently.

Prediction of Training Success without M-70 Performance

Discriminant models for each criterion level were also run without the inclusion of the initial M-70 training data as predictors. Tables B9 through B16a in Appendix B show the summary output of these discriminant analyses. Again, these include the variables input to the analyses, the classification and discriminant function scores, etc.

Table 10 shows the variables found to discriminate significantly for each criterion level. As for the previous models, the variables contributing to prediction at each criterion level are listed in their order of contribution of discrimination of the GO and NO GO groups. It will be noted that the set of variables again varies somewhat between criterion level predictions. However, again there is some degree of consistency across the variable sets. Arm length, eye color, height, and prior sports participation appear most consistently. Smoking, physical fitness (PT) scores, and the GM and CO scores from the ASVAB also enter into several of the predictions, while right eye acuity and handedness are found to discriminate in the upper level criterion predictions.

Table 10

Discriminating Variables by Rank and Criterion Level for M-70 Excluded Model

Rank	1650 or Better Variables	1500+ (Expert) Variables	1430+ Variables	1370+ Variables
1	Eye Color	Prior Sports Participation	Arm Length	Arm Length
2	Smoking	Eye Color	Eye Color	CO Score
3	Height	GM Score	Prior Sports Participation	GM Score
4	PT Score	Right Eye Acuity	PT Score	Eye Color
5	Right Eye Acuity	Handedness	Handedness	Height
6		PT Score		Prior Sports Participation
7		Height		
8		Arm Length		

Rank	1300+ (1st Class) Variables	1230+ Variables	1170+ Variables	1100+ (2nd Class) Variables
1	Arm Length	Arm Length	Arm Length	Arm Length
2	CO Score	Eye Color	Eye Color	CO Score
3	Prior Sports Participation	Height	CO Score	Eye Color
4	Height	Prior Sports Participation	Height	Height
5	Eye Color	PT Score	GM Score	GM Score
6	Smoking	CO Score	Prior Sports Participation	Smoking
7		Age	PT Score	Prior Sports Participation
8		Smoking	Smoking	PT Score

Table 11 summarizes the results of this set of models. The maximum variance in the performance criterion accounted for by any model is 22.3% and this value ranges downward to 10.2% for the highest criterion level. This table also shows the percentages of total correct classifications, correct selections and correct rejections for each of the calculation case and the base case. It should be read the same as Table 9.

Comparisons of the Training Prediction Models

Meaningful comparisons can be made between the two models including/excluding the initial M-70 performance by examination of Table 12. This shows the changes in the various measures of model success resulting from deletion of the M-70 as a predictor. As indicated, nearly all changes are negative, with the amount of variance accounted for by the predictors decreasing for all criterion levels. The average decrease is about 7% and ranges from 1.2% at the lowest criterion level to 13.6% at the Expert level. Similar decreases in success are indicated for all three measures of correct classifications, correct selections, and correct rejections. In general, it can be stated that the models based only on personal characteristics of the trainees do less well at predicting training success than did the models which included initial M-70 performance as a predictor, which is to be expected.

THE LIVE FIRE MODELS

Discriminant analyses were applied to the data resulting from the TCATA TOW TEA test Phase I as described earlier. The entire set of TOW gunners was used to develop and validate the discriminant models since the TCATA data showed that the training programs had no significant effect on live fire hit probability.

Preliminary analysis of data sets included multiple regressions and simple correlations to eliminate from consideration those variables either too highly intercorrelated with others or totally unrelated to the criterion of hit/miss. Following these steps, the discriminant analysis programs of the Statistical Package for the Social Sciences (Nie, et. al., 1976) were run with two sets of remaining variables. The first set included all ASVAB scores and those variables selected by prior evaluation (listed in Table 13). The second set consisted of all variables listed in Table 13 except the ASVAB variables. Selection of these variables for the final discriminant models was based on a preliminary discriminant run on the total group which indicated these variables were most importantly related to the discrimination capability.

Table 6, in the summary section, summarizes the results for the two discriminant models in terms of effectiveness of selection. It can be seen that the model using the ASVAB scores was most successful in both initial discrimination and when applied to the validation group. This model accounted for 31.1% of the variance in live fire performance and yielded 86.6% total correct classifications in the calculation group, with 88.3% correct selections and 66.7% correct rejections. For the validation group, this model yielded 82% total correct classifications, 86.9%

Table 11

Summary of Results for M-70 Excluded Model
(For all Eight Criterion Levels)

	Calculation Case (N=209)				Validation Case (N=98)		
Criterion Levels	% Variance Explained	% Total Correct	% Correct Selections	% Correct Rejections	% Total Correct	% Correct Selections	% Correct Rejections
1650 or better	10.2	77.5	17	98	69.4	10	94
1500+ (Expert)	13.3	70.3	38	92	62.2	27	84
1430+	11.2	64.4	52	74	60.2	47	74
1370+	13.0	64.6	64	65	51.0	50	52
1300+ (1st Class)	15.5	64.1	78	48	57.1	72	39
1230+	21.2	72.3	85	44	72.5	85	41
1170+	22.3	75.1	89	38	76.5	89	35
1100+ (2nd Class)	19.5	79.4	94	35	78.6	91	33

Table 12

Comparisons of the Two Models by Criterion Level
(Entries are Changes Resulting from Deletion of M-70 as a Predictor)

	Calculation Case (N=209)				Validation Case (N=98)		
Criterion Level	% Variance Explained	% Total Correct	% Correct Selections	% Correct Rejections	% Total Correct	% Correct Selections	% Correct Rejections
1650 or better	-5.5	-4.3	-3	0	-8.1	-10	-3
1500+ (Expert)	-13.6	-8.6	-10	-2	-9.2	-11	-5
1430+	-10.4	-9.3	-10	-10	-10.2	-10	-4
1370+	-12.9	-6.2	-6	-6	-8.2	-8	-9
1300+ (1st Class)	-6.1	-7.7	-4	-9	-13.3	-9	-15
1230+	-4.2	-1.4	-1	-3	0.0	-5	-14
1170+	-2.1	+1.4	-3	0	+7.4	-4	-11
1100+ (2nd Class)	-1.2	-0.9	0	+1	-1.0	-2	-5

Table 13

Final Set of Variables Included in
Live Fire Discriminant Analyses

ASVAB Scores

GM - General Maintenance
EL - Electronics
MM - Mechanical Maintenance
CO - Combat
FA - Field Artillery
GT - General Technical
CL - Clerical
OF - Operator and Food
ST - Skilled Technical
SC - Surveillance and Communications

Other Variables

Right Eye Acuity
Left Eye Acuity
Wearing Corrective Lenses
Eye Color
Lateral Phoria
Smoking Behavior
Prior Rifle Experience
Prior Shotgun Experience
Prior Pistol Experience
M16 Qualification
Months in Service
Hand Length
Handedness

correct selections, and 33.3% correct rejections. The second model, excluding the ASVAB scores, fared less well. This accounted for only 9.9% of the criterion variance and yielded only 84.7% total correct classifications in the calculation group, with 86.2% correct selections and 50% correct rejections. For the validation group, this model yielded 85.1% correct classifications and these were all correct selections - the model did not reject any gunners as unlikely to hit the target. These data are illustrated numerically in Table 14 for the validation group results using the ASVAB included model and in Table 15 for the model using only the remaining variables. These are also compared to actual live fire successes for the validation group, which amounted to 85.1% for this subset of the gunners.

The best these models could be expected to produce is represented by the thirteen variable model including the ASVAB scores; on the calculation case this yielded 88.3% correct selections. When compared to the overall live fire success rate of the unselected gunners in the test - 84.4% - this yields only a 3.9% improvement in potential performance. In the validation case the percent correct selections was only 86.9%, or a 2.5% improvement over the unselected and virtually untrained gunners in the test. These comparisons indicate that further development of selection models for TOW gunner placement is likely to be both impractical and not cost-effective.

Table 7 in the summary section shows the variables which were found to discriminate among hitters and missers in the two models. If USAIS and the US Army should choose to institute any informal selection process, these variables should be used as guidelines. Since visual acuity shows up in both selection models, it would seem feasible to make this check in units, etc., prior to training or assignment to TOW duties. The data indicate that gunners with 20/20 vision in both eyes and not wearing corrective lenses for any purpose are likely to make the better gunners. Similarly, the data indicate a slight preference for non-smokers, although this relationship is weaker than that for visual acuity.

Additional Analyses Planned But Not Performed

It was intended that a variety of additional analyses would be performed in support of the TCATA TEA test and in relation to the questions surrounding selection and prediction of TOW live fire capability. Several analyses of tracking performance on the M-70 as it related to tracking in the live fire situation were planned. These were to include both meter scores and in-flight errors measured from strip charts recorded from the M-70 tracker as compared to in-flight deviations during live fire. TCATA analyzed the M-70 meter scores in relation to live fire, both hit/miss and RDCM, and found no significant relationships, although there was some indication of a possible relationship between M-70 tracking/training on a rough surface and live fire performance. Confounding of the data collection situation during successive subgroup training and testing (of Group II trainees) renders impossible the continuation of this analysis with the current data.

Table 14

Validation Group Classification for Prediction of Live Fire Success with ASVAB Scores Included

	Predicted Performance	
Live Fire Performance	Would Hit	Would Miss
Hit (N=57)	53	4
Miss (N=10)	8	2
Total (N=67) (Excluding System Failures)	61	6

$$\text{Correct Selections} = \frac{53}{61} = 86.9\%$$

$$\text{Correct Rejections} = \frac{2}{6} = 33.33\%$$

$$\text{Actual Success} = \frac{57}{67} = 85.1\%$$

Table 15

Validation Group Classification for Prediction of Live Fire Success without ASVAB Scores

Live Fire Performance	Predicted Performance	
	Would Hit	Would Miss
Hit (N=57)	57	0
Miss (N=10)	10	0
Total (N=67) (Excluding System Failures)	67	0

$$\text{Correct Selections} = \frac{57}{67} = 85.1\%$$

$$\text{Correct Rejections} = - = 0$$

$$\text{Actual Success} = \frac{57}{67} = 85.1\%$$

The analysis of the in-flight error scores during M-70 training and live fire tracking would still be possible. However, it is a very personnel-intensive process, requiring individual reading of many strip charts to reduce the data. Further, given the outcome of the overall TOW TEA test, it would appear that the need for this analysis is greatly reduced.

It was also intended to reduce and report the data from a series of questionnaires which were to have been administered to all trainees in the test, before training, after training, and after live fire. Again, changes in test plans resulted in these questionnaires having been administered only to Group I of the trainees. Since these data would have been only for a third or less of the trainees in the test and thus were unusable for the prediction/selection effort, they were not analyzed.

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APPENDIX A

Table of Variables Used in

TOW Gunner Selection

Table A

Variables Collected for Use in Prediction of TOW Gunner Success

1. ASVAB Scores

   GM - General Maintenance
   EL - Electronics
   MM - Mechanical Maintenance
   SC - Surveillance and Communications
   CO - Combat
   FA - Field Artillery
   TG - General Technical
   CL - Clerical
   OF - Operator and Food
   ST - Skilled Technical

2. Other Variables

   Height
   Weight
   Shoulder Width
   Trunk Length
   Upper Arm Length
   Lower Arm Length
   Upper Leg Length
   Lower Leg Length
   Hand Length
   Hand Span
   Middle Finger Length
   Handedness
   Footedness
   Pursuit Rotor Errors
   Pursuit Rotor Time
   Steadiness, Hand
   Prior Sports Participation
   Smoking Behavior
   Color Blindness
   Eye Color
   Vertical Phoria
   Lateral Phoria
   Right Eye Far Acuity
   Left Eye Far Acuity
   Wearing of Corrective Lenses
   Occular Dominance
   Depth Perception
   M16A1 Qualification Level

Table A (Cont'd)

Other Variables (Cont'd)

Age
Total Months Military Service
Rifle Experience
Pistol Experience
Shotgun Experience
M-70 Average Meter Scores
Pay Grade

APPENDIX B

Summary Tables for Discriminant Analyses

<u>Tables B1 - B8a</u>: Tables for Discriminants on Training Success with M-70 Initial Performance Included.

<u>Tables B9 - B16a</u>: Tables for Discriminants on Training Success without M-70 Performance.

TABLE 1 DISCRIMINANT OUTPUT (WITH M-70): CRTTERION 1650+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77

FILE ARITOW (CREATION DATE = 01 JUN 77)
SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	TN5HRS		14.31101	1	.93534	.000	14.31102	14.31102	.000
2	EYES		9.66317	2	.89343	.000	24.69240	10.38138	.001
3	TN25HRS		3.37463	3	.87896	.000	28.50644	3.81404	.051
4	PTSCORE		2.64749	4	.86770	.000	31.56285	3.05641	.080
5	SMOKE		2.24396	5	.85821	.000	34.19993	2.63708	.104
6	HEIGHT		2.32612	6	.84844	.000	36.97668	2.77675	.096
7	ACUITYR		1.17373	7	.84351	.000	38.40131	1.42463	.233

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	8.15729	7.99546
PTSCORE	.27867	.26681
ACUITYR	2.89680	1.19830
EYES	5.40188	2.97762
SMOKE	-.28658	.82800
TN5HRS	.01239	.00510
TN25HRS	.03587	.02912
CONSTANT	-364.81498	-341.43166

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.8435	34.631	7	.000
1	.18551	100.00	.396	:					

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

MO-1650

TABLE 1a DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1650+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 135

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	-.23116
PTSCORE	-.24320
ACUITYR	-.18086
EYES	-.54602
SMOKE	.25625
TN5MRS	-.39113
TN25MRS	-.32534

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	-.07762
PTSCORE	-.00569
ACUITYR	-.81460
EYES	-1.16266
SMOKE	.53455
TN5MRS	-.00349
TN25MRS	-.00323
CONSTANT	10.42414

CENTROIDS OF GROUPS IN REDUCED SPACE

	FUNC 1
GROUP 1 GO	-1.67428
GROUP 2 NOGO	.09302

MD-1650+ L

TABLE 2 DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1500+

10S DISCRIMINANT RUN COMBINED CRITERIA (5 X 25). 23 NOV 77 PAGE 157

FILE ARATON (CREATION DATE = 01 JUN 77)

SUBFILE									
TW1	TW2	TW3	TW4	TW5	TW6	TW7	TW8	TW9	TW10
TW11	TW12	TW13	TW14						

- - - - - - - - - - - - D I S C R I M I N A N T   A N A L Y S I S - - - - - - - - - - - -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	TN5MRS	31.56792	1	.86766	.000	31.56793	31.56793	.000
2	TN25MRS	11.40486	2	.82216	.000	44.77584	13.20791	.000
3	ACUITYR	4.67693	3	.80382	.000	50.51916	5.74332	.017
4	MNTGEN	3.42494	4	.79055	.000	54.84274	4.32358	.038
5	SPORTS	3.69300	5	.77642	.000	59.60622	4.76348	.029
6	EYES	3.04763	6	.76488	.000	63.62887	4.02265	.045
7	PTSCORE	2.94378	7	.75384	.000	67.59262	3.96375	.046
8	HANDED	2.80217	8	.74343	.000	71.43989	3.84727	.050
9	HEIGHT	2.06490	9	.73579	.000	74.32885	2.88895	.089
10	AGE	1.31903	10	.73092	.000	76.20286	1.87401	.171

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
AGE	1.11720	1.20551
HEIGHT	8.01705	7.90501
PTSCORE	.27521	.26553
MNTGEN	.25466	.29616
ACUITYR	5.02521	3.32697
EYES	-1.82665	-2.09502
HANDED	-7.60413	-6.51515
SPORTS	2.04722	1.77742
TN5MRS	.00847	.00167
TN25MRS	.03255	.02433
CONSTANT	-376.21966	-363.20772

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.7309	63.316	10	.000
1	.36813	100.00	[illegible]	:					

MC-1500+a

TABLE 2a DISCRIMINANT OUTPUT (WITH M-70); CRITERION 1500+

TO DISCRIMINANT RUN COMBINED CRITERIA (5 / 25). 23 NOV 77 PAGE 15A

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
AGE	.14029
HEIGHT	-.18979
PTSCORE	-.23540
MNTGEN	.33740
ACUITYR	-.21444
EYES	-.23194
HANDED	.22312
SPORTS	-.29152
TN5MRS	-.43260
TN25MRS	-.47018

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
AGE	.05023
HEIGHT	-.06372
PTSCORE	-.00551
MNTGEN	.02360
ACUITYR	-.96587
EYES	-.49387
HANDED	.65346
SPORTS	-.15344
TN5MRS	-.00387
TN25MRS	-.00467
CONSTANT	6.98016

CENTROIDS OF GROUPS IN REDUCED SPACE

	FUNC 1
GROUP 1 GO	-1.03186
GROUP 2 NOGO	.25951

MO -1500+ L

TABLE 3 DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1430+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25).　　　　06 DEC 77　　　　PAGE 134

FILE ARITOW (CREATION DATE = 01 JUN 77)

SUBFILE	TW1	TW2	TW3	TW4	TW5	TW6	TW7	TW8	TW9	TW10
	TW11	TW12	TW13	TW14						

- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	TNSHRS		27.83875	1	.88146	.000	27.83876	27.83876	.000
2	AMFNHN		6.91639	2	.85282	.000	35.72362	7.88486	.005
3	TN25HRS		6.36704	3	.82713	.000	43.26229	7.53867	.006
4	EYES		3.25006	4	.81416	.000	47.24938	3.98709	.046
5	PTSCORE		3.75250	5	.79939	.000	51.94884	4.69946	.030
6	MNTGEN		1.38489	6	.79394	.000	53.72420	1.77537	.183
7	COMBAT		2.58808	7	.78385	.000	57.08164	3.35743	.067

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
PTSCORE	.22481	.21806
MNTGEN	.21610	.24725
COMBAT	.55210	.52173
AMFNHN	4.13188	3.99378
EYES	-2.68560	-3.56993
TNSHRS	.02299	.01731
TN25HRS	.01959	.01539
CONSTANT	-164.61977	-154.08326

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.7838	40.560	7	.000
1	.27576	100.00	.465	:					

MO-1430 m

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 3a DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1430+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 135

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
PTSCORE	-.23736
MNTGEN	.36668
COMBAT	-.29845
AMENHN	-.31572
EYES	-.34198
TN5MRS	-.52330
TN25MRS	-.34837

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
PTSCORE	-.00555
MNTGEN	.02565
COMBAT	-.02501
AMENHN	-.11371
EYES	-.72819
TN5MRS	-.00468
TN25MRS	-.00346
CONSTANT	8.55935

CENTROIDS OF GROUPS IN REDUCED SPACE

	FUNC 1
GROUP 1 GO	-.59497
GROUP 2 NOGO	.36156

MO -1430+ 6

TABLE 4 DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1370+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 138

FILE ARITOW (CREATION DATE = 01 JUN 77)
SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	TN25MRS		33.89692	1	.85929	.000	33.89688	33.89688	.000
2	TN5MRS		8.19519	2	.82641	.000	43.48036	9.58348	.002
3	AMFNHN		7.47306	3	.79735	.000	52.61125	9.13089	.003
4	HEIGHT		5.87099	4	.77504	.000	60.08318	7.47192	.006
5	COMBAT		2.27290	5	.76646	.000	63.07357	2.99039	.084
6	MNTGEN		5.08283	6	.74765	.000	69.86933	6.79576	.009
7	EYES		1.87728	7	.74073	.000	72.45519	2.585[illegible]	.108

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	7.01961	7.16358
MNTGEN	.06877	.10992
COMBAT	.59329	.54650
AMFNHN	1.52617	1.31017
EYES	-8.22284	-8.75979
TN5MRS	.00014	-.00424
TN25MRS	.01811	.01084
CONSTANT	-305.63652	-304.10459

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.7407	61.075	7	.000
1	.35002	100.00	.509	:					

MC-1370+a

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 4a DISCRIMINANT OUTPUT (WITH M-70): DRITERION 1370+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 132

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
WEIGHT	.31411
MNTGEN	.43095
COMBAT	-.40901
AMFNHN	-.43931
EYFS	-.18473
TN5MRS	-.35893
TN25MRS	-.53611

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
WEIGHT	.10547
MNTGEN	.03015
COMBAT	-.03427
AMFNHN	-.15823
EYFS	-.39334
TN5MRS	-.00321
TN25MRS	-.00533
CONSTANT	1.12955

CENTROIDS OF GROUPS IN REDUCED SPACE

		FUNC 1
GROUP GO	1	-.58073
GROUP NOGO	2	.51531

MO 1370+6

TABLE 5 DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1300+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 23 NOV 77 PAGE 133

FILE ARITOW (CREATION DATE = 01 JUN 77)

SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10 TW11 TW12 TW13 TW14

- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	TN5HRS		21.49890	1	.90591	.000	21.40891	21.40891	.000
2	AMFNHN		10.29597	2	.86279	.000	32.91916	11.42025	.001
3	COMBAT		9.15900	3	.82589	.000	43.63837	10.71921	.001
4	HEIGHT		4.31717	4	.80877	.000	48.94310	5.30473	.021
5	TN25HRS		3.71234	5	.79425	.000	53.62364	4.68054	.031
6	SPORTS		2.81328	6	.78334	.000	57.25331	3.62967	.057

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	7.03388	7.15280
COMBAT	.54635	.50902
AMFNHN	1.92860	1.67429
SPORTS	1.98616	1.83023
TN5HRS	-.00908	-.01381
TN25HRS	.01654	.01292
CONSTANT	-308.84248	-302.65924

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.7833	42.815	6	.000
1	.27659	100.00	.465	:					

M0-1300+a

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 5a DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1300+

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	.28933
COMBAT	-.35762
AMFNHN	-.56685
SPORTS	-.23783
TN5HRS	-.42864
TN25HRS	-.29251

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	.09547
COMBAT	-.02997
AMFNHN	-.20417
SPORTS	-.12518
TN5HRS	-.00383
TN25HRS	-.00291
CONSTANT	5.12128

CENTROIDS OF GROUPS IN REDUCED SPACE

		FUNC 1
GROUP GO	1	-.33307
GROUP NOGO	2	.68738

M0-1300+f

TABLE 6 DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1230+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 147

FILE AHITOW (CREATION DATE = 01 JUN 77)
SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- - - - - - - - - - - - D I S C R I M I N A N T   A N A L Y S I S - - - - - - - - - - - -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	TN25MRS	18.99696	1	.91594	.000	18.99695	18.99695	.000
2	AMFNMN	14.53097	2	.85559	.000	34.93822	15.94127	.000
3	HEIGHT	7.54785	3	.82521	.000	43.84654	8.90832	.003
4	EYES	8.10184	4	.79369	.000	53.80889	9.96234	.002
5	SPORTS	5.22283	5	.77378	.000	60.51902	6.71013	.010
6	PTSCORE	4.87701	6	.75554	.000	66.97768	6.45867	.011
7	AGE	1.46900	7	.75005	.000	68.97997	2.00229	.157
8	SMOKE	1.13142	8	.74583	.000	70.54121	1.56124	.211

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
AGE	1.43846	1.52611
HEIGHT	7.28799	7.46395
PTSCORE	.25422	.24405
AMFNMN	1.44453	1.08901
EYES	1.38580	.10717
SPORTS	1.77575	1.53720
SMOKE	2.51379	2.94083
TN25MRS	.02215	.01497
CONSTANT	-352.59985	-347.96544

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.7458	59.530	8	.000
1	.34078	100.00	.504	:					

no 1230rc

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 6a DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1230+

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
AGE	-.15563
HEIGHT	-.33314
PTSCORE	.27615
AMFNHN	.62748
EYES	.38173
SPORTS	.28811
SMOKE	-.13014
TN25MRS	.45876

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
AGE	-.05572
HEIGHT	-.11186
PTSCORE	.00646
AMFNHN	.22601
EYES	.81283
SPORTS	.15165
SMOKE	-.27147
TN25MRS	.00456
CONSTANT	-3.25364

CENTROIDS OF GROUPS IN REDUCED SPACE

		FUNC 1
GROUP GO	1	.28204
GROUP NOGO	2	-.89687

m o-1230+ L

TABLE 7 DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1170+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 152

FILE ARITOW (CREATION DATE = 01 JUN 77)
SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- D I S C R I M I N A N T A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	AMFNHN		18.40504	1	.91835	.000	18.40526	18.40526	.000
2	TN25MRS		16.34597	2	.85083	.000	36.29103	17.88576	.000
3	HEIGHT		7.61258	3	.82037	.000	45.32673	9.03571	.003
4	EYES		5.87693	4	.79740	.000	52.59588	7.26915	.007
5	PTSCORE		3.18673	5	.78507	.000	56.67086	4.07498	.044
6	SPORTS		2.49981	6	.77548	.000	59.93388	3.26302	.071
7	SMOKE		1.12007	7	.77118	.000	61.42137	1.48749	.223
8	COMBAT		1.05143	8	.76715	.000	62.83240	1.41103	.235
9	MNTGEN		2.92914	9	.75602	.000	66.80432	3.97192	.046

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	7.24989	7.45652
PTSCORE	.24535	.23786
MNTGEN	.15330	.18902
COMBAT	.43053	.38517
AMFNHN	1.44535	1.03712
EYES	-4.39455	-5.66054
SPORTS	1.79406	1.63862
SMOKE	1.76713	2.24558
TN25MRS	.01481	.00725
CONSTANT	-362.48634	-356.63197

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.7560	56.639	9	.000
1	.32272	100.00	.494	:					

me 1170 fe

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 7a DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1170+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 153

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	-.36591
PTSCORE	.19042
MNTGEN	-.30360
COMBAT	.32186
AMFNHN	.67393
EYFS	.35352
SPORTS	.17559
SMOKE	-.13638
TN25MRS	.45197

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	-.12286
PTSCORE	.00446
MNTGEN	-.02124
COMBAT	.02697
AMFNHN	.24273
EYFS	.75277
SPORTS	.09242
SMOKE	-.28449
TN25MRS	.00449
CONSTANT	-3.88758

CENTROIDS OF GROUPS IN REDUCED SPACE

		FUNC 1
GROUP GO	1	.23229
GROUP NOGO	2	-1.04532

MD 1170+ b.

TABLE 8 DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1100+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 23 NOV 77 PAGE 142

FILE ARITOW (CREATION DATE = 01 JUN 77)
SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	AMFNHN		23.02095	1	.89992	.000	23.02097	23.02097	.000
2	TN25HRS		9.47033	2	.86036	.000	33.59557	10.57460	.001
3	HEIGHT		6.05353	3	.83569	.000	40.70049	7.10491	.008
4	SMOKE		3.63407	4	.82106	.000	45.11305	4.41256	.036
5	EYES		4.02053	5	.80512	.000	50.10628	4.99323	.025
6	PTSCORE		2.12260	6	.79674	.000	52.80758	2.70130	.100
7	SPORTS		1.24975	7	.79182	.000	54.42297	1.61539	.204

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	7.47002	7.67016
PTSCORE	.25451	.24663
AMFNHN	1.45770	.97449
EYES	.84371	-.22560
SPORTS	1.98632	1.84539
SMOKE	1.75190	2.66554
TN25HRS	.02276	.01642
CONSTANT	-344.55767	-337.75425

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.7918	47.501	7	.000
1	.26291	100.00	.456	:					

no vota.

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 8a DISCRIMINANT OUTPUT (WITH M-70): CRITERION 1100+

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	-.35489
PTSCORE	.20057
AMFNHN	.79878
EYFS	.29900
SPORTS	.15942
SMOKE	-.26078
TN25MRS	.37973

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	-.11916
PTSCORE	.00469
AMFNHN	.28770
EYFS	.63668
SPORTS	.08391
SMOKE	-.54399
TN25MRS	.00377
CONSTANT	-4.53994

CENTROIDS OF GROUPS IN REDUCED SPACE

		FUNC 1
GROUP GO	1	.17903
GROUP NOGO	2	-1.15728

MO-1100+L

TABLE 9 DISCRIMINANT OUTPUT (NO M-70): CRITERION 1650+

FILE ARITOW (CREATION DATE = 01 JUN 77)
SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- - - - - - - - - - D I S C R I M I N A N T A N A L Y S I S - - - - - - - - - -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	EYES		13.55804	1	.93853	.000	13.55804	13.55804	.000
2	SMOKE		2.73318	2	.92624	.000	16.48438	2.92634	.087
3	HEIGHT		2.79034	3	.91380	.000	19.52561	3.04123	.081
4	PTSCORE		2.27743	4	.90371	.000	22.05452	2.52891	.112
5	ACUITYR		1.29315	5	.89799	.001	23.51359	1.45906	.227

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	8.19902	8.02368
PTSCORE	.27597	.26552
ACUITYR	2.99201	1.27314
EYES	6.75232	3.93467
SMOKE	-.25691	.90261
CONSTANT	-356.11572	-336.70218

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.8980	22.003	5	.001
1	.11359	100.00	.319	:					

0-1650 r e

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 9a DISCRIMINANT OUTPUT (NO M-70): CRITERION 1650+

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	-.33025
PTSCORE	-.28256
ACUITYR	-.24133
EYES	-.83680
SMOKE	.35150

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	-.11089
PTSCORE	-.00661
ACUITYR	-1.08699
EYES	-1.78182
SMOKE	.73325
CONSTANT	11.63880

CENTROIDS OF GROUPS IN REDUCED SPACE

		FUNC 1
GROUP GO	1	-1.35178
GROUP NOGO	2	.07510

0-1650+8

TABLE 10 DISCRIMINANT OUTPUT (NO M-70): CRITERION 1500+

FILE ARITOW (CREATION DATE = 01 JUN 77)
SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	SPORTS	7.54936	1	.96481	.006	7.54937	7.54937	.006
2	ACUITYR	5.28405	2	.94068	.002	13.05203	5.50267	.019
3	AMFNHN	3.82390	3	.92346	.001	17.15718	4.10515	.043
4	EYES	3.02512	4	.90996	.001	20.48121	3.32403	.068
5	HHTGEN	4.12058	5	.89186	.000	25.09886	4.61765	.032
6	HANDED	2.23292	6	.88211	.000	27.66449	2.56563	.109
7	PTSCORE	1.91428	7	.87379	.000	29.89949	2.23500	.135
8	HEIGHT	1.52632	8	.86717	.000	31.70700	1.80751	.179

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	7.76423	7.67893
PTSCORE	.26785	.26114
HHTGEN	.32745	.35914
ACUITYR	.92904	-.68326
AMFNHN	1.31094	1.22079
EYES	-2.05464	-3.18809
HANDED	-7.39555	-6.43296
SPORTS	2.69209	2.54709
CONSTANT	-370.65253	-359.62500

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.8672	28.932	8	.000
1	.15316	100.00	.364	:					

CLASSIFICATION COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION (S)

TABLE 10a DISCRIMINANT OUTPUT (NO M-70): CRITERION 1500+

FOR DISCRIMINANT RUN COMBINED CRITERIA (5 25). 14 NOV 77 PAGE 174

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	.24400
PTSCORE	.27579
HNTGEN	-.43506
ACUITYR	.34379
AMPHNH	.24036
EYES	.51119
HANDED	-.31563
SPORTS	.62947

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	.08193
PTSCORE	.00645
HNTGEN	-.03044
ACUITYR	1.54847
AMPHNH	.08657
EYES	1.08850
HANDED	-.92441
SPORTS	.33132
CONSTANT	-10.31891

CENTROIDS OF GROUPS IN REDUCED SPACE

	FUNC 1
GROUP 1 GO	.72500
GROUP 2 NOGO	-.18233

01500+t.

TABLE 11 DISCRIMINANT OUTPUT (NO M-70): CRITERION 1430+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 148

FILE ARITOW (CREATION DATE = 01 JUN 77)
SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- D I S C R I M I N A N T A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	AMFNHN	8.25662	1	.96164	.005	8.25682	8.25682	.004
2	EYES	8.02997	2	.92556	.000	16.64762	8.39080	.004
3	SPORTS	4.74230	3	.90464	.000	21.82130	5.17368	.023
4	PTSCORE	2.49940	4	.89369	.000	24.62445	2.80315	.094
5	HANDED	1.38448	5	.88763	.000	26.20414	1.57970	.209

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
PTSCORE	.22952	.22354
AMFNHN	4.45772	4.29105
EYES	5.71161	4.79809
HANDED	-.35929	.17402
SPORTS	1.63957	1.45152
CONSTANT	-127.41315	-118.84768

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.8876	24.375	5	.000
1	.12659	100.00	.335	:					

D-14301a

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 11a DISCRIMINANT OUTPUT (NO M-70): CRITERION 1430+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 149

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
PTSCORE	.33026
AMFNHN	.59845
EYES	.55484
HANDED	-.23550
SPORTS	.46204

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
PTSCORE	.00773
AMFNHN	.21555
EYES	1.18143
HANDED	-.68972
SPORTS	.24320
CONSTANT	-10.99329

CENTROIDS OF GROUPS IN REDUCED SPACE

		FUNC 1
GROUP GO	1	.42898
GROUP NOGO	2	-.26069

0 1430+6

TABLE 12 DISCRIMINANT OUTPUT (NO M-70): CRITERION 1370+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 153

FILE ARITOW (CREATION DATE = 01 JUN 77)
SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- D I S C R I M I N A N T A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	AMFNMN		9.30867	1	.95697	.003	9.30858	9.30858	.002
2	EYES		4.77346	2	.93529	.001	14.32091	5.01233	.025
3	HEIGHT		4.47669	3	.91531	.000	19.15441	4.83350	.028
4	SPORTS		3.06956	4	.90174	.000	22.55731	3.40290	.065
5	COMBAT		2.33319	5	.89149	.000	25.19575	2.63844	.104
6	MNTGEN		4.85175	6	.87058	.000	30.77276	5.57700	.018

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	7.12478	7.23447
MNTGEN	.08701	.11965
COMBAT	.57380	.52959
AMFNMN	1.72839	1.50871
EYES	-8.56227	-9.28649
SPORTS	1.84885	1.71960
CONSTANT	-310.06712	-308.68407

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.8706	28.274	6	.000
1	.14866	100.00	.360	:					

0-1370+a

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 12a DISCRIMINANT OUTPUT (NO M-70): CRITERION 1370+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 154

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	.39812
MNTGEN	.56864
COMBAT	-.64297
AMFNMN	-.74325
EYFS	-.41447
SPORTS	-.29923

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	.13368
MNTGEN	.03978
COMBAT	-.05388
AMFNMN	-.26770
EYFS	-.88254
SPORTS	-.15750
CONSTANT	1.69067

CENTROIDS OF GROUPS IN REDUCED SPACE

	FUNC 1
GROUP 1 GO	-.35377
GROUP 2 NOGO	.36408

0.1370 + b

TABLE 13 DISCRIMINANT OUTPUT (NO M-70): CRITERION 1300+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 23 NOV 77 PAGE 148

FILE ARITOW (CREATION DATE = 01 JUN 77)

SUBFILE	TW1	TW2	TW3	TW4	TW5	TW6	TW7	TW8	TW9	TW10
	TW11	TW12	TW13	TW14						

\- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	AMFNHN		11.69103	1	.94654	.001	11.69082	11.69082	.001
2	COMBAT		9.91254	2	.90309	.000	22.21402	10.52320	.001
3	SPORTS		7.76308	3	.87013	.000	30.88395	8.67003	.003
4	HEIGHT		2.80729	4	.85832	.000	34.16921	3.27426	.070
5	EYES		1.95762	5	.85012	.000	36.49391	2.32570	.127
6	SMOKE		1.01515	6	.84587	.000	37.71759	1.22368	.269

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	7.09449	7.19465
COMBAT	.66499	.63069
AMFNHN	1.89890	1.63746
EYES	-7.77579	-8.31279
SPORTS	2.08037	1.86781
SMOKE	1.25986	1.59995
CONSTANT	-313.49970	-308.19809

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.8459	34.147	6	.000
1	.18221	100.00	.393	:					

013ee1c

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 13a DISCRIMINANT OUTPUT (NO M-70): CRITERION 1300+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 23 NOV 77 PAGE 149

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
WEIGHT	.30642
COMBAT	-.42064
AMFNMN	-.74606
EYES	-.25921
SPORTS	-.41507
SMOKE	.16757

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
WEIGHT	.10295
COMBAT	-.03525
AMFNMN	-.26872
EYES	-.55195
SPORTS	-.21848
SMOKE	.34956
CONSTANT	5.58188

CENTROIDS OF GROUPS IN REDUCED SPACE

		FUNC 1
GROUP GO	1	-.28092
GROUP NOGO	2	.5[illegible]

0 /300+ F

TABLE 14 DISCRIMINANT OUTPUT (NO M-70): CRITERION 1230+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 163

FILE ARITON (CREATION DATE = 01 JUN 77)
SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	AMFNMN		15.87281	1	.92878	.000	15.87256	15.87256	.000
2	EYES		10.66898	2	.88305	.000	27.41538	11.54282	.001
3	HEIGHT		7.70991	3	.85104	.000	36.23202	8.81664	.003
4	SPORTS		6.95942	4	.82296	.000	44.52982	8.29779	.004
5	PTSCORE		4.69787	5	.80435	.000	50.35058	5.82076	.016
6	COMBAT		2.08843	6	.79612	.000	53.01105	2.66047	.103
7	AGE		1.00141	7	.79217	.000	54.30640	1.29535	.255
8	SMOKE		1.06428	8	.78798	.000	55.69690	1.39050	.238

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
AGE	1.48901	1.55975
HEIGHT	7.11623	7.28500
PTSCORE	.24061	.23154
COMBAT	.56118	.53656
AMFNMN	1.49003	1.13545
EYES	-2.79907	-4.03402
SPORTS	1.60051	1.34937
SMOKE	2.21883	2.62187
CONSTANT	-369.39235	-364.32608

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.7880	48.371	8	.000
1	.26907	100.00	.460	:					

0-1230/c

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 14a DISCRIMINANT OUTPUT (NO M-70): CRITERION 1230+

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
AGE	.14529
HEIGHT	.36962
PTSCORE	-.28522
COMBAT	-.21607
AMFNHN	-.72392
EYES	-.42649
SPORTS	-.35086
SMOKE	.14208

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
AGE	.05201
HEIGHT	.12411
PTSCORE	-.00667
COMBAT	-.01811
AMFNHN	-.26074
EYES	-.90812
SPORTS	-.18468
SMOKE	.29639
CONSTANT	4.00642

CENTROIDS OF GROUPS IN REDUCED SPACE

	FUNC 1
GROUP 1 GO	-.25759
GROUP 2 NOGO	.81914

O-1230+ F.

TABLE 15 DISCRIMINANT OUTPUT (NO M-70): CRITERION 1170+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 06 DEC 77 PAGE 168

FILE ARITOW (CREATION DATE = 01 JUN 77)

SUBFILE TW1 TW2 TW3 TW4 TW5 TW6 TW7 TW8 TW9 TW10
TW11 TW12 TW13 TW14

- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	AMFNHN		18.40504	1	.91835	.000	18.40526	18.40526	.000
2	EYES		8.09898	2	.88361	.000	27.26717	8.86191	.003
3	HEIGHT		7.60282	3	.85201	.000	35.95658	8.68941	.003
4	SPORTS		3.95950	4	.83579	.000	40.67222	4.71564	.030
5	PTSCORE		2.94584	5	.82383	.000	44.26613	3.59391	.058
6	COMBAT		2.14565	6	.81517	.000	46.93501	2.66888	.102
7	MNTGEN		2.18224	7	.80642	.000	49.69213	2.75712	.097
8	SMOKE		1.07356	8	.80211	.000	51.07001	1.37788	.240

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	7.28085	7.47168
PTSCORE	.24442	.23740
MNTGEN	.16503	.19476
COMBAT	.43780	.38873
AMFNHN	1.43818	1.03361
EYES	-4.24381	-5.58673
SPORTS	1.85249	1.66723
SMOKE	1.83589	2.27925
CONSTANT	-361.51486	-356.39906

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.8021	40.764	8	.000
1	.24671	100.00	.445	:					

1-1170.

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 15a DISCRIMINANT OUTPUT (NO M-70): CRITERION 1170+

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	.39810
PTSCORE	-.21000
MNTGEN	.29772
COMBAT	-.41018
AMFNHN	-.78682
EYFS	-.44178
SPORTS	-.24655
SMOKE	.14888

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	.13367
PTSCORE	-.00491
MNTGEN	.02083
COMBAT	-.03437
AMFNHN	-.28339
EYFS	-.94070
SPORTS	-.12977
SMOKE	.31057
CONSTANT	3.94966

CENTROIDS OF GROUPS IN REDUCED SPACE

		FUNC 1
GROUP GO	1	-.20920
GROUP NOGO	2	.94181

0 1170 - 2.

TABLE 16 DISCRIMINANT OUTPUT (NO M-70): CRITERION 1100+

TOW DISCRIMINANT RUN COMBINED CRITERIA (5 & 25). 23 NOV 77 PAGE 158

FILE ARITOW (CREATION DATE = 01 JUN 77)

SUBFILE	TW1	TW2	TW3	TW4	TW5	TW6	TW7	TW8	TW9	TW10
	TW11	TW12	TW13	TW14						

- D I S C R I M I N A N T   A N A L Y S I S -

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS' LAMBDA	SIG.	RAO'S V	CHANGE IN RAO'S V	SIG. OF CHANGE
1	AMFNHN		23.02095	1	.89992	.000	23.02097	23.02097	.000
2	HEIGHT		5.29944	2	.87735	.000	28.93862	5.91765	.015
3	EYES		5.65679	3	.85379	.000	35.44913	6.51051	.011
4	SMOKE		4.07442	4	.83707	.000	40.29148	4.84235	.028
5	COMBAT		2.48546	5	.82694	.000	43.31919	3.02772	.082
6	MNIGEN		2.24174	6	.81787	.000	46.09692	2.77773	.096
7	SPORTS		1.68387	7	.81107	.000	48.21723	2.12031	.145
8	PTSCORE		1.39354	8	.80546	.000	49.99513	1.77790	.183

CLASSIFICATION FUNCTION COEFFICIENTS

	GROUP 1 GO	GROUP 2 NOGO
HEIGHT	7.28053	7.47336
PTSCORE	.24396	.23742
MNIGEN	.16364	.19524
COMBAT	.43862	.38818
AMFNHN	1.50640	1.01858
EYES	-4.35486	-5.57889
SPORTS	1.82923	1.66967
SMOKE	1.44868	2.34913
CONSTANT	-362.33661	-355.46014

DISCRIMINANT FUNCTION	EIGENVALUE	RELATIVE PERCENTAGE	CANONICAL CORRELATION	:	FUNCTIONS DERIVED	WILKS' LAMBDA	CHI-SQUARE	DF	SIGNIFICANCE
				:	0	.8055	43.917	8	.000
1	.24152	100.00	.441	:					

6 11 Oct.

REMAINING COMPUTATIONS WILL BE BASED ON 1 DISCRIMINANT FUNCTION(S)

TABLE 16a DISCRIMINANT OUTPUT (NO M-70): CRITERION 1100+

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	.35982
PTSCORE	-.17500
MNTGEN	.28304
COMBAT	-.37716
AMENHN	-.84858
EYES	-.36016
SPORTS	-.18993
SMOKE	.27045

UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
HEIGHT	.12082
PTSCORE	-.00409
MNTGEN	.01980
COMBAT	-.03160
AMENHN	-.30564
EYES	-.76690
SPORTS	-.09997
SMOKE	.56417
CONSTANT	4.78115

CENTROIDS OF GROUPS IN REDUCED SPACE

		FUNC 1
GROUP GO	1	-.17306
GROUP NOGO	2	1.11872

0-1100+L